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Baltimore's New Imhoff Tanks

WHEN the Baltimore sewage-treatment works were designed in 1906 the Imhoff tank was an untried device in the United States, and consequently sedimentation was provided for by three long rectangular open basins designed to serve a population of 488,000. It is significant to note that in increasing the capacity of the plant to care for the sewage of 600,000 people the designs for the original sedimentation tanks have been abandoned and Imhoff tanks selected in their place. The new installation of twenty-eight tank units, for which a contract was let recently, is described in an article by Leslie C. Frank, their designer, on page 4 of this issue. The features of the additional sedimentation equipment are the use of the small instead of the large unit, to secure greater operating flexibility, and the adoption of the radial flow principle, with a detention period of 2 hours. The Baltimore installation is the most recent large-scale program of sewage treatment in this country, and as such the reasons which governed its design should interest sanitary engineers.

Security of Tenure

A NOVEL form of insurance—against the losses due to dismissal from public office—is being urged upon its members by the officers of the Institution of Municipal and County Engineers, of Great Britain. A company, entirely mutual in character, known as Official Security, Ltd., has been formed for the purpose of issuing the insurance, which will apply in all cases except for dismissal on account of misconduct. Not only are the direct losses insured to the extent of two-thirds of the salary, but the litigation expenses incident to actions brought against officers in connection with their public duties or brought by the officers for libel, slander, assault, and the like in connection with their offices, are covered. This proposal will seem strange to public officials in the United States, for frequent changes in office are inherent in our political system, though subordinate positions are quite generally protected by civil service. In Europe, however, long tenure is the rule, and the upsetting of a man's life-work by dismissal prompted by jealousy or resentment is a serious matter. Moreover, the communications urging members to protect themselves indicate that unjust dismissals and serious litigation are by no means infrequent. The engineer in his judicial capacity is quite likely to offend politicians and those concerned with the execution of public works. In fact, the better public official he is, the more diligent in protecting the interests of his ultimate employer—the public—the more is he apt to

meet adverse criticism. With these facts in mind the formation of the new company seems amply justified. Possibly, too, economists will see in the move another evidence of the careful provision for the future so strongly emphasized by the old-age pensions which have recently become effective in Great Britain.

Pork on the Griddle

PROBABLY never before in its history has the notorious pork measure of our Congress—the Rivers and Harbors Bill—been destined for the grilling it will shortly receive in the Senate. Possibly by the time this issue reaches its readers the fight will be on, and all right-thinking men the country over will pray for more power to Senator Burton—better informed on waterways than any man in Congress—for he will lead the attack on this iniquitous measure. Protests have been made annually against its wastefulness. Careful consideration has been urged for a more intelligent policy. Earnest have been the prayers of economists and engineers for measures that would make our waterways a greater factor in our internal commerce—yet selfish ends have dominated the Congress, and the same bait of a creek improved has been thrown to the voters to the detriment of those projects which have had real merit. The Engineering Record invites the attention of its readers to the statement of Senator Burton's position on page 6 of this issue. With the "reforms" he advocates all right-thinking men will agree. But mere agreement mentally is of no value. The exercise of one's influence by a letter to Senatorial and House representatives can alone be effective, while direct indorsement to Senator Burton of his stand will hearten him in the fight. He deserves the support, in a special manner, of the engineers of the country. They know the problem, and their influence, if brought to bear, will be correspondingly more effective.

A Slur on the Profession

IN advocating the placing of the Alaska Railway work in sole charge of the army engineers a high Government official gave as his reason that the army's record at Panama showed that it could carry through a large enterprise without the suspicion of graft. No one wishes to detract from the credit of those who have so successfully put through that great work. This journal has not been niggardly in its praise, yet it agrees that the comparison, as made by the official, casts a slur on the profession. He inferred, perhaps unconsciously, that sterling honesty was at a premium among civilian engineers, for the very point under discussion was the desirability of their

strong representation on the commission. A little reflection will show that when judged by results civilian engineers have amply proved their trustworthiness, no less than their capacity. The expenditure of \$375,000,000 in ten years is no small responsibility, yet the outlay for engineering works under civilians in this country annually exceeds that amount, and the cases of engineering dishonesty are so few as to be numbered on one's fingers. Moreover, there are large corporations whose engineers annually approve of expenditures, which, if not equal to the average at Panama, are large enough to form a temptation of no mean proportions. The possibilities of graft on \$30,000,000 are greater than on \$10,000,000, but it requires a most consummate rogue to spurn the opportunities in the smaller appropriation because of its dimensions. It would be well for all engineers—and those in the army will surely join in so doing—to have a ready retort for the slurring remark, even though it came from a place of power.

Interest in Quantity Surveying

QUANTITY surveying is by no means a novel idea to experienced engineers and contractors. Its advantages have been pointed out in this journal in the past and periodically some one advocates its adoption. Recently, however, more than ordinary interest has been aroused, so that there is hope that this system will make some headway among engineers and contractors. The present interest is due to the active advocacy of the plan by a number of associations, notably the American Institute of Quantity Surveyors, organized about a year ago in San Francisco. A very clear idea of the objects and advantages of quantity surveying were given in this journal on May 30, page 606, in an abstract of an address by Leslie H. Allen, of Boston. For the benefit of those not conversant with the plan it may be stated briefly that it consists in the preparation by an individual specially qualified—the quantity surveyor—of a table of the quantities of all materials entering into the construction. Instead of each contractor doing this work for himself, only one man does it, the quantity surveyor. There is, therefore, a general saving, which in the end will redound to all owners in the cutting down of contractors' overhead charges. Furthermore, there is the assurance that all contractors are bidding on an equal basis, that serious error in "taking-off" quantities has been eliminated. The advantages of the method need not be urged on most engineers, for the quite general practice of supplying lists of materials to bidders on engineering works shows that its merits have long since been appreciated. There is a

curious anomaly, however, in that engineers when they come to building construction generally fail to include a bill of materials with the plans. Custom has decreed it so, yet there is as good reason for furnishing a quantity survey with concrete building drawings and specifications as with those for a rapid-transit subway. It is manifest, of course, that there are situations in which, with our present customs, accurate bills of quantities are out of question. With the superficial underground surveys preceding many grading contracts close estimates of the amounts of rock and earth are out of the question. Similar cases will occur to every engineer and contractor. These practices are, however, changing. It is being recognized that thorough examination of conditions saves money in the end, so that gradually we are approaching conditions under which quantity surveys can generally be supplied. Standards of measurement, in an unsatisfactory condition in the building trades, are better standardized in general engineering work so that the application to such construction may be more easily brought about than in building work. Apparently, however, those back of the present activities of the associations interested in the promotion of quantity surveying are aiming principally at the architect. He is the more grievous offender, but certainly many engineers, too, need to be awakened to the value of an accurate quantity survey.

Practical Study of Blasting

THE cost of blasting rock depends largely on the arrangement and depth of the holes and the amount of explosive used. The desideratum is a minimum cost of drilling and explosive per unit of rock satisfactorily dislodged. Satisfactory dislodgment requires not only that the rock be detached from the ledge, but that it be broken into pieces of suitable size for handling. Unnecessary danger and expense are likely to be incurred if the rock is broken into very small fragments, and additional time and expense are involved if the pieces are so large that they must be again drilled and blasted or mud-capped before they can be removed.

The questions involved are often left to the determination of the foreman, who usually works by rule of thumb, without taking into consideration all of the local conditions. The character of the rock and the requirements vary so much that each case should be the subject of careful observation and analysis. The details should be determined through a wise combination of analytical and experimental results. The manner in which this may be done is indicated by an article in this issue, which gives specific results of rock work in a steam-shovel cut and proceeds to analyze them to determine the depth and spacing of drill holes. Obviously the conditions in different localities have an important bearing on the result, so that fixed rules cannot be adopted for all classes of work.

An important point made is the necessity for careful study and experiment to eliminate the need of excessive mud-capping,

which becomes more common as the holes are deeper. The objection to mud-capping is the principal argument against the use of holes from 50 to 100 ft. deep, heretofore in common use in large quarry operations. It is evident from current practice that this system is gradually changing, for more rapid progress can be made if the depth of the holes is limited to about 30 ft.

Lime as an Aid in Chuting Concrete

THE constantly increasing popularity of the method of transporting concrete by means of a centrally located elevator discharging into inclined chutes is sufficient evidence of its superior economy or convenience, or both. The older and still more common method of transporting concrete in barrows or buggies often permits the separation of the materials and if the carrying vehicle is not promptly emptied after its jolting passage over runways and ramps it is necessary to dig out the settled heavy aggregate. The result, in some cases, is a concrete lacking in uniformity. The spouting method, when used without intermediate receiving hoppers, is also liable to produce segregation of the coarse aggregate when the mixture is not of proper consistency, or the aggregate is so coarse that the pieces separate themselves from the slower moving mass of mortar, go bounding down the chute and are projected to the far side of the form, while the mortar falls vertically off the end with but little of the coarse aggregate left in it.

The cause of this separation of the mortar and the coarse aggregate is either that the concrete is too wet or the aggregate too large. Sometimes it is due to the spout being too steep, thus producing too high a velocity in the stream of concrete and so facilitating the separation of the larger pieces from the remainder of the mixture. Another result of the modern system has been to cause, or at least to encourage the use of very wet mixtures.

The effective radius of an elevator tower of a given height, depends, of course, upon the inclination of the spouts, and this, in turn, depends upon the fluidity of the concrete handled. The tendency, therefore, is to use wet mixtures in order that steep spouts, and consequently tall elevators, may be avoided.

The use of an excess of water over that required to lubricate the mass and assist the particles to settle into place so as to fill the voids and produce a dense structure is detrimental to strength and also to impermeability. There is danger, too, of washing the cement through the crevices of forms which are not watertight, and of causing an increased accumulation of laitance on the top of the mass.

In the effort to overcome one or more of these difficulties and to produce a mixture that will flow on relatively flat inclines and be of such a sticky, pasty consistency as to hold the coarse aggregate in the mortar it has been proposed to add hydrated lime to the mixture. It is claimed that the addition of lime makes an easier flowing mass, one which is "fat" and sticky and from

which there is less tendency for the coarse aggregate to separate, that the permeability of the resulting concrete is materially decreased, and all this without the sacrifice of strength and at slight or no additional cost. In fact, these results are stated to have been secured on a number of Pacific Coast projects.

All of these results are worth attaining, and if so simple a remedy as lime will cure these ills there will be little ground for objecting to its use; but will it cure them? The answers of those who have experimented with 10 per cent of hydrated lime in the mix is an unhesitating affirmative. Certainly the method deserves very careful investigation.

A word as to cost. With cement at \$1 per barrel, or \$5.30 per ton, and lime at \$8 per ton, and with the added trouble and expense of placing one more ingredient in each batch, even though an equivalent amount of cement be deducted from the mix, there seems to be little encouragement on the score of economy.

The whole matter is one of much importance. Either lime is a good thing to add to concrete which is to be spouted into place, or it is not. Claims made for or against it will not change the facts in the case, and while the results secured on the Coast are not here questioned, the issues are so important that wide study is called for. A thorough investigation ought to be made by a proper committee of one of the technical societies. Its report would be of much value. While there have been objections to the spouting of concrete—and the concrete road conference at Chicago last February condemned the method for road work—its advantages are so manifest that the logical thing is to seek a remedy for the evils rather than advocate its abandonment. Some organization similar to the American Concrete Institute should be in a position to handle the investigation.

Flood Control as an Investment

THE attempt to control floods is expensive and has usually been regarded as part of the price we pay for the advantages of large river systems and fertile lowlands. The many millions spent in recent years safeguarding property along the rivers of the United States doubtless are a good investment from the standpoint of insurance, but of course there is no cash return. In contrast to this the Colorado River situation, where there is now urgent need of preventive measures, gives some promise of affording a field for profitable investment, of a sort, however, which only the Government can undertake.

Anticipating the ultimate need of a broader general scheme than any yet undertaken, for controlling the Colorado, engineers have gone into the matter thoroughly and have voiced the opinion that a combined system of flood control and storage for irrigation should be worked out. It is thought that a system of reservoirs could be established by which the stream flow could be so regulated that water would be available for gravity distribution over a million acres of desert land on American

territory, as rich as that already reclaimed. Detailed investigation may show that this can or cannot be done at a profit, but inasmuch as the serious flood menace to the Imperial Valley during the month of June calls for prompt and decisive action, the Engineering Record urges that consideration be given to the probable profit, as well as the threatened loss, in deciding upon the nature and extent of the protective work.

The Colorado has always presented serious flood problems. There is no bottom for the foundations of structures, borings to a depth of 2000 ft. near the Imperial Valley having shown nothing more solid than fine alluvial silt. Then, too, silt is continually carried in suspension and wherever stream conditions favor its deposition the river bed is built up higher and higher until the waters overflow and find a lower channel. Thus, to keep the stream in bounds it has been the custom to build levees and dikes. The only material available is the friable silt, which will stand well enough when dry and well-faced against the current, but which literally "melts" once the levee is broken and the waters begin to cut through the unprotected earth. When a levee breaks during high water a large area is quickly submerged because of the flat contour, and the engineer is confronted with a lake into which the levees run like two narrow peninsulas, with their ends being rapidly eaten away while dry material is not to be obtained for many miles.

These conditions are well known, of course, to all who are familiar with the Imperial Valley, and in fact the habit of associating levees with protection work there has grown so strong that hardly had the recent flood waters receded when there came a demand from some centers for the construction of a more extended and strong system of levees, to begin below Yuma and extend far enough toward Laguna Salada to safeguard the New River and the Alamo Channel. This is a matter, however, in which only the engineer should give advice, and fortunately several eminent members of the profession have already studied the situation. They point out that while it may be necessary to depend on levees until a better safeguard is provided the levee system at best can give only a temporary and auxiliary protection, as it is an endeavor to control the destructive floods under unfavorable conditions. The need is to prevent the floods entirely.

An appropriation of \$50,000 was made by Congress last March for the use of the Reclamation Service in investigating storage units and irrigation systems which might be developed on the Colorado. In an item on this matter in the issue of May 23 the Engineering Record referred to several storage sites on the Colorado known to have a capacity of between 6,000,000 and 7,000,000 acre-feet. This capacity would be sufficient to retain the full flood flow of the Colorado at 140,000 sec.-ft. for a period of 25 days.

It has been claimed that \$30,000 per year is sufficient for maintaining a system of levees and canals in the Imperial Valley, but it is notable that this year \$151,000 has already been raised for fighting floods; of

this amount \$85,000 came from mutual water companies, \$55,000 from Government funds and the remainder from local organizations and private citizens. Compared to this the annual maintenance charge for a system of storage dams would certainly be a small figure. As to the initial cost, it is worth while to consider whether or not the Government lands to be benefited could be withdrawn from entry at once and later sold under the new value they would have by virtue of the water rights, at a figure sufficient to cover the cost of the dams.

Critical Bridge Work Successfully Accomplished

CRITICAL work, unprecedented for the dimensions and methods involved, has just been successfully accomplished in the substitution of four nickel-steel main-chord pins for smaller carbon-steel pins in the trusses of the 300-ft. shore spans of the Williamsburg Bridge, New York. The details are given on page 13 of this issue. This work completes a series of operations in progress for about three years, by which the capacity of portions of the old structure has been considerably increased, its potential strength developed, and provision made for traffic requirements much greater than were anticipated when the structure was designed. The expense has been small in comparison with the cost of the bridge, and the work has been done without interference to traffic.

The replacement of the pins was required to carry out an ingenious plan for increasing the efficiency of the existing structure by a revision of span lengths and the wind-bracing system. It was effected by the addition of a few new members and the reinforcement of old ones without materially interfering with the original construction.

The most difficult of the many operations involved was the pin replacement, involving the removal of the old pins, the enlargement of the holes and the driving of the new pins. In all these operations speed was an important factor. Each replacement necessitated the disconnection of a vital joint in the truss and the maintenance of the disconnected members in exactly the same position for several hours, while subject to possible vibrations, temperature changes and the still more important movements that might be occasioned by the taking up of the elastic after-effects when the material had been relieved of heavy stresses.

A system of temporary members was applied, which securely clamped the released permanent members of the truss together and prevented their relative displacement. The necessary transfer of stresses from old to new members was accurately measured by a system of extensometer observations, checking all of the important operations. The actual work of cutting was accomplished by an entirely new machine, working with extreme accuracy and at a speed about twice as great as that of ordinary high-speed machine-shop boring practice. The design of the machine and the provisions made for its rapid and perfect adjustment and rigid support were important features in the success of the work.

Although the details may not be applicable to other bridges, the principles and methods have been demonstrated with such great success that they will afford valuable aid in solving problems that may arise in the field on other bridges and steelwork. High credit is due to those who foresaw the probable and possible difficulties of this complicated and unusual problem. No less credit should be given those who provided efficiently for the execution and developed the powerful and accurate tool by which the heavy work was done rapidly under adverse conditions.

Safety First—Why Not on Construction?

THE growth of the "safety-first" movement is little known except to those directly engaged in the lessening of industrial and transportation accidents, or who have had occasion to investigate the activities of safety and welfare departments. The results secured are no less astonishing than the variety and ingenuity of schemes used to impress the dangers on the minds of employees.

To many the safety movement means the enclosing of dangerous gear wheels, belts and saws within wire guards. These devices have, it is true, helped materially to reduce accidents, but even greater have been the results of campaigns which do not involve the protection from machinery at all. A series of photographs, for example, prepared by the safety department of the Inland Steel Company, is devoted almost entirely to these other phases of safety work. The dangers from unprotected manholes, upturned nails in discarded timber, insecure placing of ladders, the mounting ladders with only one free hand, etc., are vividly shown.

Accurate statistics kept by industrial plants indicate that nine out of every ten accidents can be prevented if all of the workmen are alert to the dangers. Hence the strenuous efforts being made to spread a knowledge of accident prevention.

With all the effort being made to prevent the 40,000 deaths in industries annually and to cut down the appalling record (2,000,000) of people maimed every year, it is surprising that contractors have taken little interest in the movement. That does not indicate that they are hard-hearted, for anyone acquainted with construction work knows that every contractor is deeply concerned over the safety of his men. He cannot have eyes everywhere, however. This is necessary with the class of labor now common on public-works construction. Therefore, the toll of deaths and injuries goes on, checked only by the interest of each particular employer and the fear of the compensation laws which are rapidly becoming country-wide.

The proper angle to approach is through the education of the men themselves, and since this can be better accomplished by the ways and means so successfully employed in industries, it is both humane and profitable for the contractor to adopt the same methods.

Imhoff Tanks to Increase Capacity of Baltimore's Sewage Treatment Plant

Twenty-Eight Units Are Under Construction in Addition to Sixteen Sludge-Digestion Tanks and 260,000 Square Feet of Drying Beds

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IN the latter part of 1913 the writer was retained by the Baltimore Sewerage Commission and given the problem of designing additional sewage treatment equipment for that city. The new works, on which construction was begun recently, comprise twenty-eight Imhoff tank units, sixteen cylindrical sludge digestion tanks and 260,000 sq. ft. of sludge-drying beds, located adjacent to Baltimore's present sewage treatment plant on the Back River. (See Engineering Record Feb. 27, 1909, page 237, Nov. 13, 1909, page 545, Nov. 20, 1909, page 580, and Feb. 24, 1912, page 200.)

The existing plant, as completed and in operation, was designed in 1906 by Ezra B. Whitman, division engineer of the Baltimore Sewerage Commission, under the general direction of Calvin W. Hendrick, chief engineer, and in conjunction with a board of advisory engineers consisting of Rudolph Hering, Samuel M. Gray and Frederic P. Stearns. The design represented the best practice in the art of sewage disposal at that time. The plant receives the sewage of Baltimore through a single large outfall sewer 30,370 ft. long, 12 ft. 3 in. in horizontal diameter, and 11 ft. high. The original plant consists of a preliminary screen chamber designed to serve 1,000,000 people; meter house with five 42 x 21-in. Venturi meters; three preliminary plain sedimentation tanks, each of 3,300,000 gal. working capacity; three preliminary sludge tanks, each of 146,000 cu. ft. capacity; single sludge bed, 100 x 400 ft. in area; sprinkling filter control house; twelve acres of sprinkling filters, each acre serving 20,000 people; two final settling basins, to serve 600,000 people; hydro-electric power house, generating power from available head in the treated sewage; and a final effluent conduit, discharging into the Back River.

In addition to the above equipment in operation there are now practically completed 18 additional acres of sprinkling filters, bringing the total sprinkling filter capacity to a 600,000 population basis.

PRESENT OPERATING METHODS

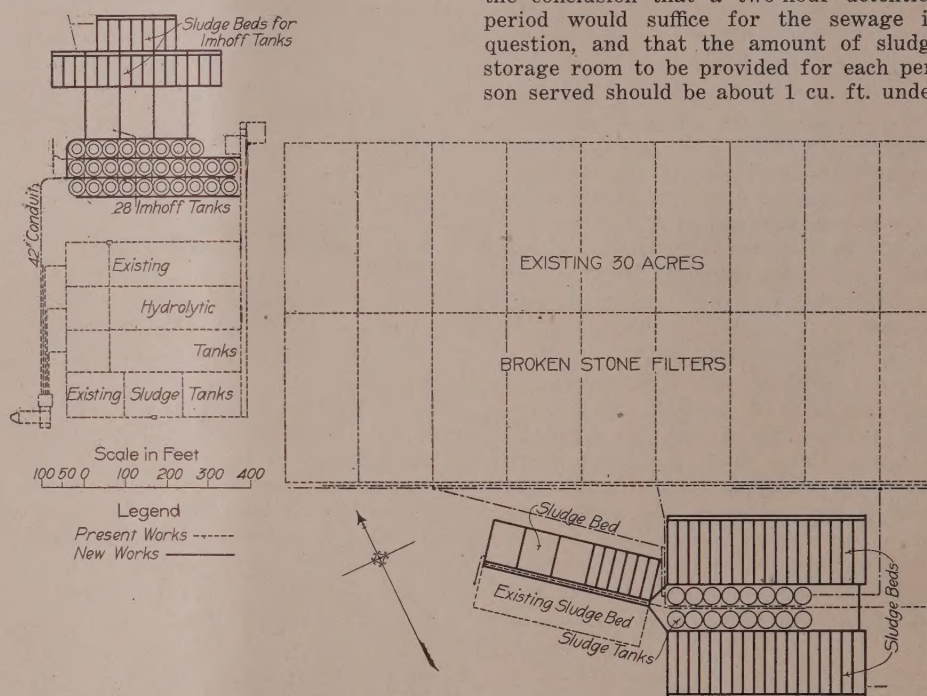
The procedure adopted in operating the preliminary sedimentation tanks is to keep a given tank in operation until it shows signs of undesirable septic action. Then the supernatant liquid is pumped off into one of the other tanks and the residual sludge pumped into one or more of the three preliminary sludge tanks. The emptying and cleaning operation consumes at present somewhat less than a week per tank. Hence it is necessary to regard one of the tanks as reserve capacity, and to exclude it in estimating the capacity of the group of tanks. This capacity has been estimated to be sufficient for 488,000 people, operation experience having shown two hours to be sufficient for optimum settling efficiency.

The operation of the present three sludge tanks has not, as yet, proceeded to a stage where it is possible to state with finality the degree of satisfaction they

will eventually afford. They are but 13 ft. deep—rather shallow when compared with the depth of 25 to 30 ft. below water line of the usual type of Imhoff tank. The sludge in them possesses the normal characteristic odor of properly digested sludge (faintly like hot sealing wax) but often shows a rather high moisture content and dries somewhat slowly. It is hoped that prolonged operation of these digestion

In designing the Imhoff units it was estimated that on the basis of a two-hour detention period the present preliminary sedimentation tanks would care for 488,000 inhabitants. Therefore, to increase the plant to a 600,000 population basis it was necessary to add a sedimentation capacity for 112,000 people. The twenty-eight Imhoff units shown on the accompanying plan were designed for this part of the population.

Careful consideration of past experience, both in Baltimore and elsewhere, led to the conclusion that a two-hour detention period would suffice for the sewage in question, and that the amount of sludge storage room to be provided for each person served should be about 1 cu. ft. under



RELATION OF NEW AND OLD SEWAGE-TREATMENT WORKS AT BALTIMORE

tanks will cause the decomposition process to acquire a higher moisture-reducing efficiency and the resulting sludge to have a shorter drying period. On the whole the results thus far obtained with the separate sludge digestion tanks at Baltimore are decidedly gratifying. The writer knows of no plants except such as use Imhoff tanks where the results are better.

The sprinkling filters have operated remarkably well. Four of the three-acre units have been in operation several years now and there are no evidences of pooling. The beds seems to store and unload periodically in a proper manner. The amount of digested sludge discharged from these filters, and capable of settling in the final settling tanks, has been estimated by the writer to be about 0.45 cu. ft. every six months per inhabitant contributing.

The operation of the final settling basins has been similar to that of the preliminary sedimentation tanks. As soon as one of them shows signs of undesirable septic action it is cleaned, the supernatant liquid being flowed off with the effluent and the residual sludge being pumped into the existing separate digestion tanks for proper decomposition.

the conditions existing in the proposed Imhoff tanks. The tanks were designed in accordance with these figures.

The sludge beds were designed on the basis of about three inhabitants per square foot of sludge bed area for preliminary sludge and about ten inhabitants per square foot of sludge bed area for final sludge. These are believed to be reasonable assumptions for the conditions existing at Baltimore.

The sixteen separate sludge digestion tanks were included in the design to care for the preliminary sludge in excess of that provided for in the three existing tanks and to care for all of the sludge from the final settling basins. It was assumed that 1.5 cu. ft. per inhabitant should be charged to the existing shallow tanks and that 1 cu. ft. per inhabitant should be charged to the proposed deep separate digestion tanks.

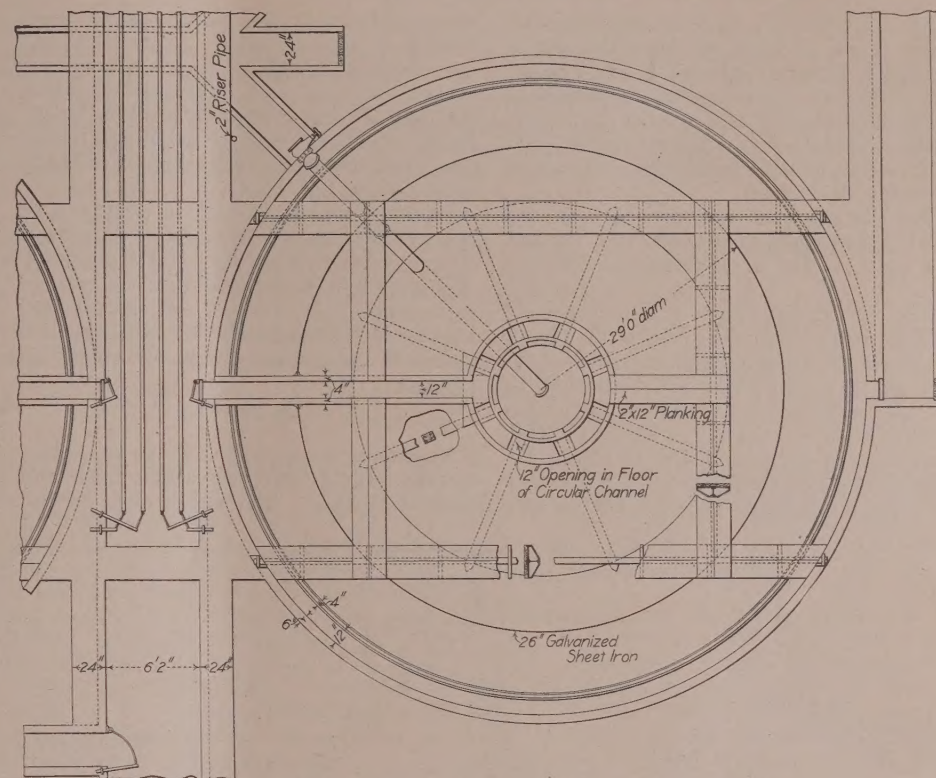
RADIAL FLOW

The twenty-eight Imhoff tanks were designed as individual radial flow units of 40 ft. maximum diameter. The small sized individual unit system was adopted for several reasons. Small sized individual

units permit of greater elasticity of operation and this elasticity is especially needed at the Baltimore plant, where the existing three units are extremely large. Again, small individual units mean less trouble when something goes wrong with the plant. Only that unit in which the trouble is found need be taken out of operation. Thirdly, small individual units have a much shorter flow line than elongated multiple units and if the flow line is not made too short this works to advantage because, with a given detention period, the velocity of flow is correspondingly low, and hence it takes a higher unexpected overloading to reach the critical swirling velocity. Finally, small sized units permit a greater ease and range of operation experiments and this is unquestionably desirable in view of the present status of the sewage disposal problem. Experiments on a small scale are good, but experiments on a large scale are better, and it is believed that the future operation of the Baltimore plant may be brought to the maximum operation efficiency by admitting such experimentation.

The units were made cylindrical rather than rectangular because careful analysis showed the cylindrical construction to be considerably cheaper. The cylindrical design also permits a radial flow which gives exactly equal treatment to every particle of sewage, which would obviously seem to result in the most efficient device.

The twenty-eight units are arranged in three parallel rows served by two distributor channels and two collector channels placed alternately. The distributor channels were divided into sub-channels by longitudinal walls in such a manner that one sub-channel serves not more than four tanks. This subdivision was made because it is easier to distribute equally a given flow among few units than among many units, and experience with distribution problems has shown that four tanks are not too many to be served by one distributor. Of course, in subdividing a given channel, the total difference in water level in its length is increased, but this increase may be neutralized by increasing the total



PLAN OF TANK, SHOWING DIVIDED FEED CHANNEL

width of channel. This was done in the present instance. The whole distributor system has been so computed hydraulically that the elevation of water surface at the initial point of subdivision is practically the same in all the sub-channels. This has resulted, of course, in sub-channels of different widths. The distributor channels have, in addition, been provided throughout with adjustable distributor wings so that when the plant is taken into operation the whole system may be regulated to the desired nicety.

In traversing the system the sewage passes from the main influent channel through a radial channel 12 in. wide and 12 in. deep to a central ring distributor

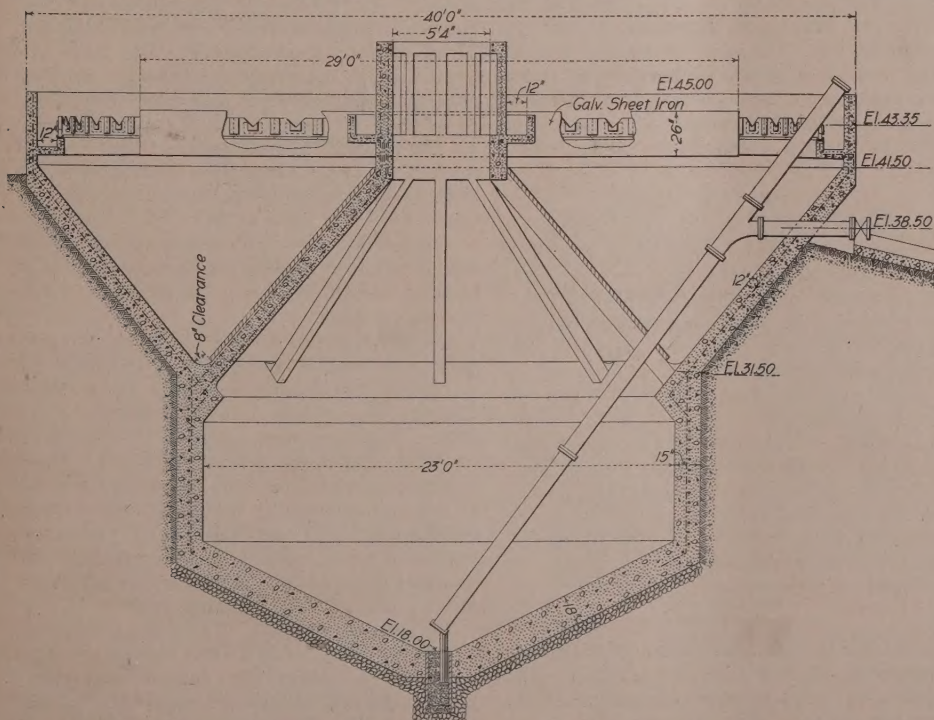
channel. This central ring channel is also 12 in. wide and 12 in. deep and contains in its bottom eight uniformly distributed 12 in. square openings through which the sewage drops into the settling chamber. The total area of these openings is sufficient to prevent harmful velocities and their situation is such that the sewage sludge, upon entering the settling chamber, is immediately given a downward impulse toward the slot. At the same time this feature tends to prevent the too rapid transit of near surface currents from inlet to outlet. To secure equal discharge through the eight openings flat plates may be placed on the floor of the channel in such a manner as partly to close those nearest the radial influent channel. The proper closure for each opening will be determined by simple experimentation.

CIRCUMFERENTIAL COLLECTORS

The sewage is taken from the settling channel by a circumferential collector channel provided with 90-deg. V-shaped weirs. There are fifty of these for each tank and they are 2 ft. 3 in. apart. The main weir wall is of gulf cypress fastened in sections into a shallow bottom section of concrete. The individual weirs are made of galvanized iron plate No. 14 B. & S. gage. They are each provided with two vertical slots into which fit thumbscrews to fasten the plates to the cypress wall. These slotted weir plates make the construction of the weir extremely simple as no extreme accuracy is necessary in the initial construction. After the plant is finished each individual plate may be adjusted simply by loosening the thumbscrews. It is also possible by means of these slotted weir plates easily to correct for a subsequent settling of the tanks.

From the circumferential collector channel the sewage flows into the main collector channel and thence into the outlet channel leading to the sprinkling filter control house.

The sludge chamber has been designed



CROSS-SECTION OF RADIAL-FLOW IMHOFF TANK UNIT AT BALTIMORE

on the basis of 1 cu. ft. per inhabitant. The depth of sludge chamber below the slot is 13.5 ft., making a total depth below water line of 25.5 ft. The slope of the bottom of the sludge chamber is 1 vertical to 2 horizontal. The sludge discharge pipe is 8 in. in diameter and its outlet center line is 5 ft. below water line.

The clearance of the slot between the settling and sludge chambers is 8 in. and the neat overlap in a horizontal plane is 8 in.

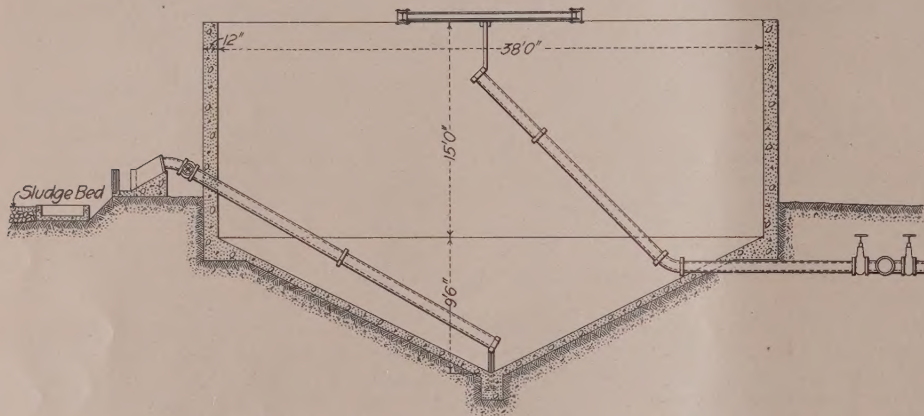
The conical diaphragm wall between the settling and sludge chambers is to have a minimum thickness of $2\frac{1}{2}$ in. and the details of its construction are to be left to the contractor subject, however, to the approval of the engineer. First thought seemed to indicate that the plastered expanded metal form of construction for this wall was undoubtedly superior but further

decomposition in the tanks due to their protrusion above ground. Experiences under practically similar conditions of climate in Germany support this view. Should the rate or quality of decomposition be affected contrary to expectation the tanks may easily be insulated by a steep embankment around the sides.

It should be noted that it will be possible, under this arrangement if found desirable, to mix preliminary and final sludge in the proper ratio for the maximum rate of decomposition. It is not altogether certain as yet that this will be necessary but it was thought wise to make the operation possible.

SLUDGE BEDS

There are about 260,000 sq. ft. of sludge-drying beds to be constructed under the present contract. The sludge beds for the



SECTION OF SEPARATE DIGESTION TANK FOR SLUDGE AT BALTIMORE

careful consideration showed that there were many advantages also in the use of steel rod reinforcement, and it was therefore decided to give the contractor an opportunity of using what seemed to him the most economical or desirable form of construction consistent with the necessary strength.

SLUDGE DIGESTION TANKS

The separate sludge digestion tanks were placed in two rows of eight tanks each on opposite sides of the sludge pipe connecting the existing sludge digesting tanks with the existing final settling tanks. This was done to make three operations possible; To pump sludge from the final settling basins to the proposed separate digestion tanks; to pump sludge from the final settling basins to the existing separate digestion tanks; to pump sludge from the existing to the proposed separate digestion tanks. Maximum operation elasticity is obtained by this arrangement.

The proposed tanks are 40 ft. in diameter and 24 ft. 6 in. in depth. The sludge influent pipe is 8 in. in diameter and leads from the sludge main to near the top of the tank. The sludge effluent pipe is also 8 in. in diameter, and leads directly into the sludge bed distributor channel. Both sludge pipes are furnished with gate valves. The walls of the tanks were made 12 in. thick and provided with substantial footings. The bottoms of the tanks were made but 6 in. thick since the tanks are to rest practically upon the surface of the ground and the bottoms not subject to any unbalanced stresses.

It is not believed that the low temperatures found in Baltimore during the winter months will affect the rate or quality of

Imhoff tanks have been placed adjacent to them, and the sludge beds for the separate digestion tanks have been placed in two rows on opposite sides of the tank system. Most of the sludge bed units have been made 26 ft. wide though there are a few larger units in one of the groups. The length of the Imhoff sludge bed units has been made 76 ft. 4 in., and of the separate digestion sludge bed units 100 and 150 ft. The sludge bed material comprises 4 in. of sand upon an 11-in. layer of gravel or broken stone. The division walls are of plank and 2 x 4-in. timber. The unit drains are 4-in. open drain tile and the collector drains are 8-in. open drain tile emptying into a 12-in. terra cotta sewer pipe.

COST

A preliminary survey of the prices of the successful bidder indicates that the Imhoff tank installation will cost approximately \$5,000 per million gallons of sewage treated. It should be noted in this connection that the detention period is two hours and that the amount of excavation is somewhat less than is likely to be the case generally.

In making the design for the new installation, under the general direction of Calvin W. Hendrick, chief engineer, the writer had the valuable co-operation of Henry C. McRae, division engineer, and of Gustav J. Requardt, assistant division engineer of the Baltimore Sewerage Commission.

STEAM-SHOVEL OPERATIONS in the removal of material adjacent to the Culebra cut as a preventive against slides were permanently discontinued June 8, according to the "Canal Record."

Bitter Fight over River and Harbor Appropriation Bill

Senator Burton, in Minority Report, Attacks "Dribbling Policy" of Partial Appropriations without Provision for Completion

By agreement of the Democratic leaders of the United States Senate the river and harbor appropriation bill is to be considered concurrently with the interstate-trade commission bill. This means that when there are no orators ready to debate one measure the other one will be laid before the Senate for action. Every indication promises that the fight over the present river and harbor bill will be the bitterest ever waged over such a measure. Senator Burton of Ohio has presented the minority report which will be made the basis for the opposition to the bill. Senator Burton objects to the bill reported by the Senate committee on commerce on three grounds—that "there are glaring defects in the methods of making appropriations; appropriations are made for many rivers or channels which under present conditions cannot be profitably improved, especially certain inland waterways; there are large appropriations for benefits which are merely local and which in some cases only remotely or incidentally affect navigation."

PARTIAL APPROPRIATIONS

"The most conspicuous defect in methods as exemplified in the bill," says Senator Burton's minority report, "is the 'dribbling policy' of making partial appropriations for a multitude of improvements without provision for completion. A more rational system would make it desirable that, instead of the numerous projects included in this measure, a much smaller number should be provided for, and no other appropriations be made except for the maintenance of improvements already completed. Such a plan of procedure as that displayed in this bill would be considered altogether wasteful and injudicious in private enterprise, and, so far as the policies in European countries have been examined, improvements have not been adopted until completion is assured. By piecemeal appropriations the full use of the improved stream is long delayed, and in most instances the total expenditure is materially increased. An insufficient appropriation may prevent the use of proper appliances for the performance of the work. The necessity for making more than one contract and installing more than one plant must inevitably add to the cost."

With reference to the rivers and channels which Senator Burton claims cannot under present conditions be profitably improved, his report says:

"While waterways of shallow craft have shown decadence, the carrying capacity of railroads has been constantly on the increase. In the case of some waterways existing facilities are adequate for present demands and the benefit to be derived from further expenditure upon them will not be at all commensurate with the cost. This emphasizes the necessity for a re-examination of all projects according to their respective merits and the omission of those not worthy of improvement."

"A careful analysis of statistics relating to rivers and canals will show a very marked decadence in inland waterway transportation, except, of course, in bodies of water like the Great Lakes, which are comparable rather with the sea than with

ivers. The decadence of inland waterway transportation is especially noticeable in the case of artificial canals and canalized rivers.

"Beginning with the opening of the Erie Canal in 1825, an impetus was given to the development of the country surpassing any previous influence in our commercial life. This waterway gave to the city of New York its assured supremacy among the commercial cities of this country. The construction of canals continued without abatement until and about the year 1840, but many of these have been entirely abandoned and others are used for only a very limited traffic.

"The Erie Canal reached its maximum of traffic in the year 1880, and the other canals in the State of New York at a somewhat earlier date. The canal system of the State of Ohio, commenced in 1825, reached its maximum of importance in the forties. Since that time the traffic has practically disappeared and the freight carried may now be counted in pounds rather than in tons. The same facts appear in regard to numerous rivers."

WASTEFUL CANAL PROJECTS

Among the rivers on which Senator Burton opposes further improvement are the Red River below Fulton, the Arkansas River and the Missouri River between Kansas City and St. Louis. Senator Burton insists that the only rivers which can be profitably improved by the construction of locks and dams are the Monongahela, the Kanawha, and the Ohio, and possibly the Allegheny and the Black Warrior system in Alabama. He particularly emphasizes what he terms the "waste" in the Illinois and Mississippi canal project, the Muscle Shoals canal of the Tennessee River and the Big Sandy River between Kentucky and West Virginia. He also opposes the proposal to spend \$10,000,000 on the Brazos and Trinity Rivers and \$45,000 on the Cumberland River above the city of Nashville.

Senator Burton complains of the money that is being spent on the Mississippi River for levee purposes. His report asks the adoption of the following "reforms":

"1. Provision for the completion of an improvement in the bill in which it is adopted.

"2. A careful review of pending projects in the light of present conditions and the omission of all improvements which are no longer profitable.

"3. A more careful consideration before the adoption of projects. There should be especial care to avoid lock and dam construction save in streams which are capable of being made important arteries of commerce.

"4. A division of expense when exceptional advantages accrue to private property or specific localities, or when the protection of private property is the main object and navigation subordinate.

"5. The exclusion from the bill of proposed improvements which do not have to do with navigation.

"6. A general policy of improving the main stream before attention is given to branch streams and the adjustment of depths and dimensions with a view to a uniform and comprehensive plan for the development of such waterways as can profitably be utilized.

"7. Such adjustment of the relations between railways and waterways as will secure the utilization of routes partly by land

and partly by water when co-operation and utilization of both routes can be made profitable as a means of transportation.

"8. Before expenditures are incurred, make certain that sufficient terminal facilities for traffic will be afforded; also that no monopoly or undue advantage be obtained

by any individual or corporation as a result of any improvements made."

Senator Burton suggests the establishment of a commission to select and recommend projects for improvement as well as to fix the degree of participation to be borne by States and communities benefited.

Engineering Features of the Panama-Pacific International Exposition

Part IV—System of Roads, Sewerage, Gas Piping and Steam and Compressed Air Service to the Exhibit Buildings

By A. H. MARKWART
Assistant Director of Works

THE roads and pavements within the Panama-Pacific exposition grounds will be component parts of the adopted color scheme. The color is to be realized by the use of colored concrete in certain places and macadam roads of a red radiolarian chert, locally known as red rock, for other sections. In the concessions district a concrete or macadam base with a thin sheet of asphaltum will be used. In some portions of the site where macadam is used it is probable that there will be provided an asphaltum wearing surface.

In consideration of the temporary character of the exposition, curbs for roadways and paths will generally be of wood 2 in. in thickness, varying in depth from 8 to 14 in., depending upon the character of the pavement to be used. In special cases where macadam is used without top surface there will be installed box gutters on the steeper slopes, to prevent erosion. As may be supposed from the description of the site the grades of the roads are generally nearly level. In the southwest portion of the site the maximum of 5 per cent grade is obtained.

In the design of the roadways the attempt to produce the color scheme as above noted and the structural design of roads located over the recent dredger fill are of interest. Approximately 16 per cent of the exposition road area is located over this filled section. To overcome any possibility of local settlement, the base will be constructed of reinforced concrete in order to secure strength and reliability.

Exclusive of the paths built by the States and Government it is estimated that about

4,000,000 sq. ft. of pavement will be required on the site. This figure does not include the pavements inside the formal courts and entrances, where there will be required approximately 700,000 sq. ft. more.

In order to handle the construction traffic in connection with the building of the exposition a number of temporary roadways composed of crushed concrete, brick and stone debris have been provided. This material has been laid directly upon the sand and roughly rolled and will later become the sub-base for the permanent roadways.

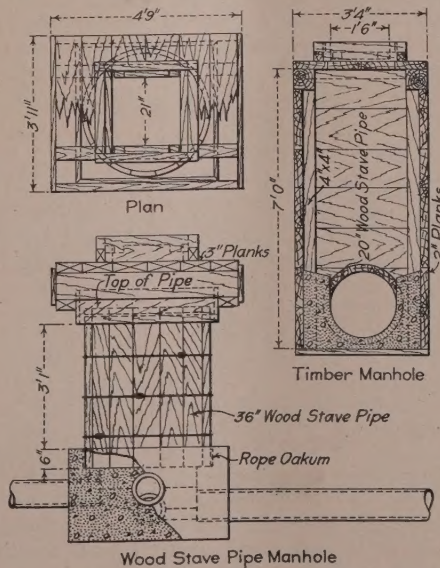
SEWERS

In the exhibit building section and in the concessions district a combined system of sewers is contemplated for the collection of storm water and sewage, while in the States and foreign districts a separate system will be provided. The storm water flow from these last named areas with that of the stock exhibit, race tracks and drill grounds will be carried directly to the bay through several convenient outfalls.

To collect the storm waters of the 63 acres of roof area of the main palaces the sewer system was carried underneath all buildings to admit directly sheet metal down spouts. Ordinarily the pipe under buildings was vitrified and in some cases was supported upon planks hung from the floor system.

In the determination of the amount of storm water to be considered in the computations of pipe sizes the San Francisco rainfall rate curve was used. This curve gives a rate of 2.16 in. per hour for a 5-min. interval and a 0.598 in. for a 60-min. interval. It was assumed that for a storm of a 5-min. duration that the runoff in the concessions district (paved roads, roofs and some yards) would be 70 per cent; from the roofs of the main exhibit palaces, 100 per cent; from the courts (paved roads and gardens), 60 per cent; from the south gardens, 25 per cent; and from the main entrance (all paved areas), 100 per cent. Further, the assumption was made, based upon a variable interval, that the runoff from the States and freight pavilion districts would be 40 per cent; from the stock exhibit, 70 per cent; from the drill grounds and race track, 60 per cent; and from the steep hillsides of the Presidio south of the race track and drill grounds, 40 per cent. The volume of sewage from the States and foreign section was taken as 20 gal. per minute from seventy buildings which it was assumed would occupy this area.

In general the starting point of the hydraulic grade was taken at El. -7.0, city base. The mean of all high tides is at El.



—6.6. Where connections were made between the exposition system and the existing city sewers at a distance of 500 ft. or more from the main city outfall, the top of the trunk sewer at the point of connection was taken as hydraulic grade point.

Inasmuch as all sewage of the States and foreign exhibit section had to be lifted with sewage pumps it was desirable to install such pipes as would reduce the leakage of ground water into the system to the minimum. Further, in view of the settlement which was constantly taking place in that portion of the exhibit palace area composed of the recent dredger fill it was found desirable to provide a type of pipe which had some flexible qualities and to meet this condition wood stave pipe was also used in the exhibit palace areas to some extent. As a rule, it was found that the greatest economy resulted in using vitrified pipe from 8 to 15 in. in diameter and wood stave pipe from 18 to 30 in. in diameter. Concrete or wooden manholes and wooden catch basins were used, a detail of which is included herewith.

GAS PIPING

There is to be a high pressure distributing system of gas mains installed by the Pacific Gas & Electric Company throughout the exposition grounds, and gas will be furnished in all exposition palaces. Oil gas, as made and used in California from crude California petroleum and having a heat value of 600 B.t.u. per cubic foot or more with a candle power in excess of 18, will be served to participants at a pressure of 30 lb. This gas is exceptionally free from sulphur and other impurities. The pressure may be reduced to anything less than 30 lb. and made suitable for the use to which the gas is to be put by means of regulators, installed and maintained by this company. The low pressure in buildings will be about 6 in. of water pressure.

In general gas will be used for lighting and heating purposes, as no other source of heat will be allowed except electric power, unless special permission has been granted. The rules and regulations are very strict on this point, as an attempt is being made to reduce the fire hazard to the minimum.

All of the ground lighting for emergency purposes will be by means of gas arcs. This provides a secondary lighting system throughout the main exhibit palace district and about such other exposition buildings and entrances as public safety may require. In the States and foreign section and in the concessions district the street lighting will be by means of gas arcs. The concessionaires in addition will provide an abundance of light as a spectacular feature, to assist in the disposal of their wares. In the concessions district the gas lighting system essentially becomes a secondary service. The rules and regulations provide that all light furnished by others than the Exposition Company, whether for decorative or other purposes, shall be of uniform brilliancy and all light sources of great intrinsic brilliancy shall be fitted with suitable globes or diffusers, so as not to cause a disagreeable effect upon the eye.

STEAM SERVICE

Steam service will be available in Machinery Hall only during the day hours. Saturated steam at a pressure of 150 lb. will be furnished through a system of mains from the Fuels building immediately to the rear of Machinery Hall and from the

central station; 1000 to 1500 boiler horsepower of steam will be supplied in this manner. In the Fuels building will be established all such exhibits as steam and gas producers. These will be working exhibits and subject to exposition awards. Steam generated in this exhibit plant will be disposed of for satisfying the steam requirements of other exhibitors.

A limited supply of compressed air at 80

lb. pressure will be available in the palaces of Machinery, Mines and Metallurgy and Transportation. The exposition will install a distributing system to these palaces, based on the use of standard screw pipe of sufficient size to handle the quantity requirement. The present plans contemplate the installation of an equipment sufficiently large to deliver 1500 cu. ft. of free air per minute.

Making Dynamite Work Efficiently

Analysis of Action of Blast with Reference to Depth and Spacing of Holes and Amount of Powder for Steam Shovel Work

By CHARLES E. ANDERSON
Civil Engineer, New York City

BLASTING for steam-shovel work requires that the rock be shattered into pieces small enough to be handled by the dipper. At the same time the powder man must prevent the rock being thrown into the air to an unnecessary extent, a result calculated not only to do damage but to waste powder. It is true that economy of powder is not always the first consideration on a construction job, but the use of the proper amount of powder, in conjunction with the best depth and burden of the holes, will result in a saving not only in powder, but in drilling and shoveling.

Getting the full efficiency out of dynamite means not only using the least possible powder, but using it in such a way as to cut drilling and "dobe" shots to the minimum. Occurring frequently, as they do on some jobs, "dobes" or mudcaps have come to be considered a necessary evil; it is not every blasting foreman who is willing to admit that the large number of these shots necessary is due to some miscalculation in his blasting methods. These necessitate the stopping of work while the men get to a safe place and many such interruptions mean considerable loss on a big job. On the other hand, incorrect depth or spacing of holes means more drilling than is necessary, and a consequent increase in that item of expense. The following paragraphs are based upon actual work in blasting for the steam shovel, and an attempt is made by comparing shots and methods to analyze the results.

Holes sometimes miss fire even though the battery is in good shape and double caps are used in the holes. This may be due in some cases to leaving wire connections bare and stringing the wire along the ground. Especially if the ground is damp it will carry off a good part of the current where the bare wires touch it.

HOLES FOR STEAM SHOVEL CUT

On a certain piece of work, the layout of the cut was as shown in Fig. 2. The holes were spaced 6 ft. apart across the cut and 10 ft. apart, measuring from the face of the bench. The cut was a new location running close to and alongside of a main line tunnel, and it was necessary to use as light charges as possible. The rock was bluestone, very tough and rather seamy, a bad combination for blasting, especially on account of the proximity of the old tunnel. The depth of holes varied from 12 to 20 ft.

Regarding the spacing holes across the cut, while a wider spacing might have done as well, the width of the cut was such that three holes were not enough, and four worked in nicely. On the other hand, the close spacing of holes across the cut insured

the thorough shattering of the rock between the holes within the limit of the force of the blast.

As to the spacing of the holes back from the face of the bench, results seemed to vary directly with the depths of the holes, so far as the apparent efficiency of the blasting was concerned. With 12-ft. holes, almost no dobeing was necessary. Where dobeing was necessary, it seems to have been on account of too light loading. As the depth of the holes increased without changing the spacing, the necessity of using mudcaps seemed likewise to increase. These results were due to some extent to the necessity of light loading. Wider spacing of the deep holes, with consequent heavier charges, would have remedied the trouble, and could have been used under ordinary circumstances.

EFFICIENCY OF RECORDED LOADING

A record was kept of the various shots, and shows that excessive mudcapping consistently followed the firing of deep holes with a light burden. Holes 1, 2, 3 and 4 in Fig. 2 were loaded respectively with 43, 15, 20, and 20 sticks of 40-per cent dynamite. Holes 5, 6, 7 and 8 were loaded with 55 sticks each, after having been sprung several times with up to 20 sticks with about 2 ft. of tamping. When finally loaded the holes were tamped full depth with clay. When these 12-ft. holes were fired the rock was lifted, shattered, and dropped back into place. Very little rock was lifted into the air, possibly because of the light loading of the front holes. It was necessary to fire one mudcap after this shot. This was probably due to the light loading.

Later, in the same arrangement of holes, the first four holes and two extras were drilled 12 ft. deep, and the second four, 20 ft. deep. The entire loading consumed 375 lb. of dynamite. This shot was followed by seven dobies. At another time four 12-ft. holes loaded with 40 sticks each and two with 60 sticks each, were fired. No mudcapping was necessary after this shot. Later a shot was fired consisting of three 20-ft. holes, two 12-ft. holes and five toe holes, consuming 375 lb. of dynamite. Before the muck from this shot was cleared away 18 dobies had to be fired.

Close spacing of holes across the cut generally assures the shattering of the rock, while the longer spacing back from the face guards against blowing the rock forward too much. Having the proper burden in front of the hole means that the rock will be lifted, shattered, and dropped back into place. There will be very little scattering and flying of the rock. At the same time, the correct depth of the hole in relation to

the burden insures that, with the proper charge, the rock will break all the way to the mouth of the hole and to the shoulder, and as a rule no big pieces will be left to dobe.

ANALYSIS OF 12-FT. HOLES

An attempt is made in Fig. 3 to analyze and explain the action of a blast, and to discover why one depth of hole will prove more efficient than another. A 12-ft. hole is shown, "sprung" or chambered at the bottom, the charge being completely within the sprung or enlarged portion of the hole. The depth of the hole is shown from a to b , and the burden is indicated by the distance W . Dynamite acts equally in all directions. Let us indicate the horizontal force of the blast by the line cd . Since the force is the same in all directions, there is also a force equal to cd , acting against the solid rock in back of the hole. It is probable that about half of this force is reflected from the solid rock in the same direction as cd . This is represented in the diagram by the line bc .

These two forces, bc and cd , represent the total force of the blast, acting horizontally on the rock to be broken. Since the force is the same in all directions, there is, acting upward, a force ef , equal to cd , and a reflected force be , equal to bc . If we construct a parallelogram of forces on these, we get as a resultant the line bg , acting at an angle of 45 deg. There is, however, another force to be reckoned with. That is, the weight of the rock which is being broken. At first glance, this force would be said to work downward, and so far as the actual weight of the rock is concerned, it does. But from a point of view of efficiency, it works upward. This may seem contradictory, but my theory may be explained as follows:

The horizontal forces, after pushing the rock outward, have done their work and the rock is broken by the direct force of the blast. After pushing the rock outward the force is dissipated through the opened fissures. The forces acting upward, however, meet an added resistance in the weight of the rock against which they are acting. Instead of falling out of the way, as does the resistance to the horizontal forces, the resistance to the vertical forces is held in place and even increased by the force of gravity. Therefore, the unspent energy of the upward forces, instead of being dissipated, goes on doing work or breaking the rock opposed to it until it is expended, or until it has forced its way through the mass and freed itself. Thus the weight of the stone, instead of acting downward, acts, from a point of efficiency, as an aid to the force of the blast, inasmuch as it holds the rock against the force until the full strength of the blast has acted on the rock. This being the case, the added force, or more properly efficiency, due to the downward pressure of the rock, is indicated in an upward direction by the line fh .

PARALLELOGRAM OF FORCES

Since the weight of the rock could not exert a force greater than the resistance due to the solid rock back of the hole, assume that fh is equal to bc . Constructing a parallelogram upon bd and bh , we get a resultant bi . It will be noticed that the distance hi , or W , is $\frac{3}{4} id$, which agrees very well with the usual proportion used in practice for the depth of hole as compared to the burden W . If we accept this explanation of the forces as correct we should say

that the 12-ft. holes used in this work were about right, or could have been a foot or so deeper, and the facts bear this out, since, when the proper charge was used, the rock was well broken with this depth of hole, and practically no mudcapping was needed after shooting 12-ft. holes.

Now let us consider the results obtained with the 20-ft. holes. It has been noted that with this depth a good many unshat-

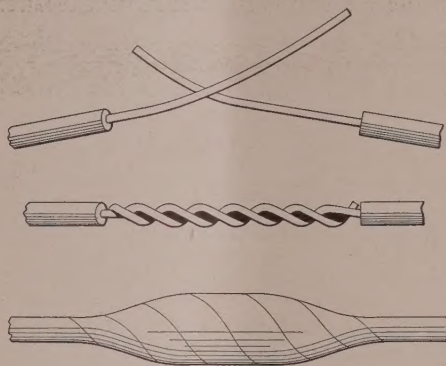


FIG. 1—CORRECT WIRE CONNECTIONS

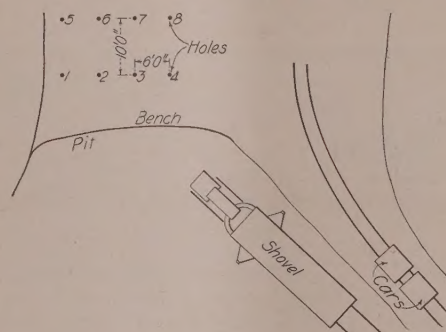


FIG. 2—PLAN OF STEAM-SHOVEL CUT

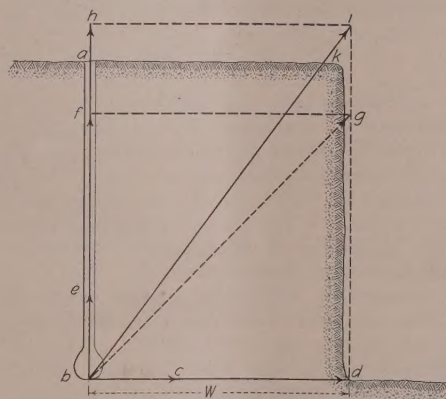


FIG. 3—12-FOOT HOLE

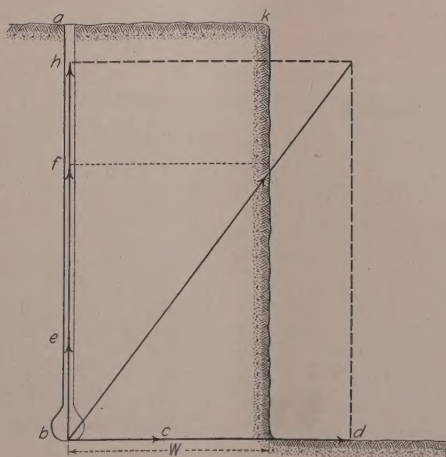


FIG. 4—20-FOOT HOLE

tered pieces were produced, which required mudcapping and consequent loss of time. The burden is indicated by the distance W , in Fig. 4. The depth of the hole is ab . In this case more dynamite is used; therefore the forces bc and cd , acting horizontally, are greater than in the former case, but are assumed to be in the same proportion. The same forces act upward, shown at be and ef . We also have the force fh , due to the weight of the rock pressing downward against the blast. As before, since the force fh cannot be greater than the resistance of the solid rock, assume it equal to bc .

Constructing a parallelogram on bd and bh , we have as before a resultant acting in the direction bi . This dissipates itself at i , where it leaves the rock. Above this point there is the rock $ikaf$, which loses the effect of the strongest force, bi , the resultant of both horizontal and upward forces, and is broken merely because it cannot resist the expansion and cohesion of the shattered rock beneath it. This overhanging piece is not, to any extent, acted upon directly by the force of the blast. Some of it is broken because it is pulled apart by its cohesion to the shattered rock below it or falls because the support is blasted from under it. Not being directly subjected to the shattering force of the dynamite, it is not shattered but falls in big pieces which must be broken later by mudcapping.

WEIGHT OF ROCK

Most writers on the subject of blasting speak of the "resistance due to the weight of the rock," treating it as simple resistance, in which case it would require more force in an upward direction than in a horizontal direction. If this were so we should have to drill our blast holes shorter than the burden, or distance W , in order to break the rock at the top of the holes. On the contrary, we almost always drill heavy blast holes deeper than W . Therefore within certain limits the weight brought about by the extra depth must be beneficial.

Authors in seeking for an explanation of the shattering forces at the mouth of the hole have mentioned the force of the escaping gases along the hole. This, it would seem, would not have a very great effect, because of the small area of the hole. On the other hand, if the confining influence of the rock is taken into consideration as above, and considered as beneficial within certain limits, it explains to a great extent the reason the rock breaks at the top of the hole as well as, or better than, that on the face of the bench. It must be remembered that the first fissure or crack opened to communicate with the atmosphere at the front lets out a certain proportion of the force acting in that direction, while the forces acting in an upward direction are confined by the weight of the rock until they have produced work to the full extent of their energy. As worked out herewith the best depth for a sprung hole should be about $\frac{4}{3} W$. This seems to agree with the practical examples given. In shorter holes where the weight of the rock would be small the conditions would of course be different, but the work described represents common practice in blasting for steam shovel work.

Most treatments of this subject consider the firing of a single hole and make the main point the computing of the charge. In general practice, the charge is best determined by trial. In general it might be

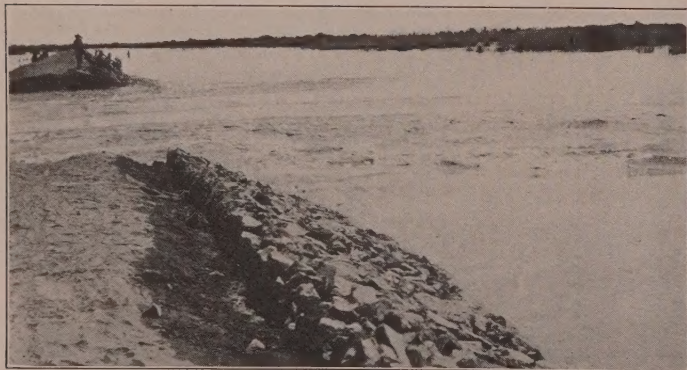
said that the weight of the charge increases as the square of the burden W . There is another question which should be given attention, and which I believe would be of considerable interest to engineers, and that is a practical comparison of results obtained by different spacing of holes across the cut. As before mentioned, most writers on the subject of blasting neglect this point and are mainly theoretical.

While it is interesting to know how to calculate charges, they are not as a rule computed in the field but are mainly estimated from the experience of the man in charge. The proper depth of hole and the reasons therefor are not always clearly understood even by the experienced rock man, and I have tried to cover them in the light of practical results. On the other hand, I have not as yet had the opportunity to compare definitely the results of various spacings of holes across the cut under similar conditions, and would like to see the matter discussed by someone who has made observations in this line.

Cabrillo Viaduct

CONSTRUCTION work at Balboa Park, the 1400-acre fair site at San Diego, Cal., which is being made ready for the exposition next year, is now well advanced. A feature of the work is the reinforced-concrete viaduct spanning Cabrillo Canyon, a picture of which appears on the front cover of this issue. The structure, seven arches supported on piers carried to bed rock, is 1010 ft. long and 136 ft. high.

TUNNEL ACCIDENTS in sixteen important works have averaged 4.7 deaths annually and nearly three times as many serious and thirteen times as many slight injuries per thousand men employed, according to Bulletin 57, issued by the U. S. Bureau of Mines. While most of the accidents were caused by ore or rock falling from the roof or walls of the tunnel, many of them were the result of ignorance or gross carelessness and could have been avoided. Many of them occurred from the improper use of explosives. To reduce the number of accidents it was recommended that roof blasts should be made with as small charges of explosives as practicable; that men be detailed to remove loose pieces of roof immediately after the blast; that each man carefully inspect the roof under which he works; and that any doubtful piece of rock be tested by impact, and if vibrations can be detected by touch or through a stick, the rock be immediately removed. Adequate timbering and great care to prevent its displacement are also necessary.



BREAK IN VOLCANO LAKE LEVEE

Break in Volcano Lake Levee

Colorado River Flood Situation at Imperial Valley—A Serious Break Was Prevented and a Levee of Lesser Importance Failed

THE first two weeks of June were anxious days in Imperial Valley, and emergency methods were adopted in strengthening levees at weak points and fighting the advance of rising waters. The crest of the flood in the Colorado River is thought to have passed Yuma, Ariz., June 15 or 16, and June 17 the waters were reported falling, with no serious danger impending and no breaks in the system of levees that protect the valley save that near Volcano Lake indicated on the accompanying map.

A detailed report written in Calexico for the Engineering Record on June 17 states that the only serious danger to Imperial Valley would have been in the breaking of the levee at a threatened point about 6 mi. south of Andrade, which would have cut

called out. The protection work was at its height about June 10, when a carload of empty sacks was received at Calexico and immediately sent to the field crews. Some difficulty is always experienced in reinforcing the levees, as they are built of extremely friable material, the only material available, which absorbs water readily and yields rapidly to current action.

The Volcano Lake levee remained intact until 1 a. m. June 11, when a break occurred that had increased to a width of 125 ft. and a depth of about 18 ft. before it was checked by bags filled and placed at its margin. This break is at a point, as shown on the map, about 15½ mi. due south of the boundary and about 25 mi. from Calexico by road.

It was expected that this break would admit water once more to New River Channel, down which it would sweep to Salton Sea. If this occurred Encina flume, which conveys some 500 or 600 sec.-ft. across the lands west of New River, would be seriously endangered. This is the only source of supply for both domestic and irrigation uses in water districts 6, 8 and 12, and crosses the channel at the head of a deep wash where it would be subject to a heavy rush of water if the flood rose to this outlet. Large forces were therefore put to work to protect Encina flume at the crossing by falsework bulkheads and riprap, while the channel was cleared of bush that might otherwise spread the current.

Although a flow of 12,000 sec.-ft. passed continuously through the break and the district flooded was almost level, the water had only approached to within 8 mi. of Encina flume by June 17. The submerged area, however, had attained a width of several miles, which meant that no dry material was available for work on the break within this distance. A patrol was maintained to give alarm should the escaped flood waters approach Alamo River Canal, the main flume, which is now carrying between 3000 and 4000 sec.-ft., or about the maximum safe capacity.

It has not been considered advisable to make any attempt to shut off the flow through the Volcano Lake levee break, efforts having been confined to prevent the opening from enlarging and the current from cutting away the unprotected bank. On June 16 the levee had been reinforced by bags filled and placed along its upstream face for a distance of 2 mi. west from the break. No other threatened fail-



VIEW OF UNPROTECTED LEVEE

away the banks of the main canal supplying the valley. Brig.-Gen. W. L. Marshall, engineer of the Department of the Interior, concentrated forces here and succeeded in raising and strengthening the levee so that an estimated flow in the river of 144,000 sec.-ft. passed without injury to the embankments at this point.

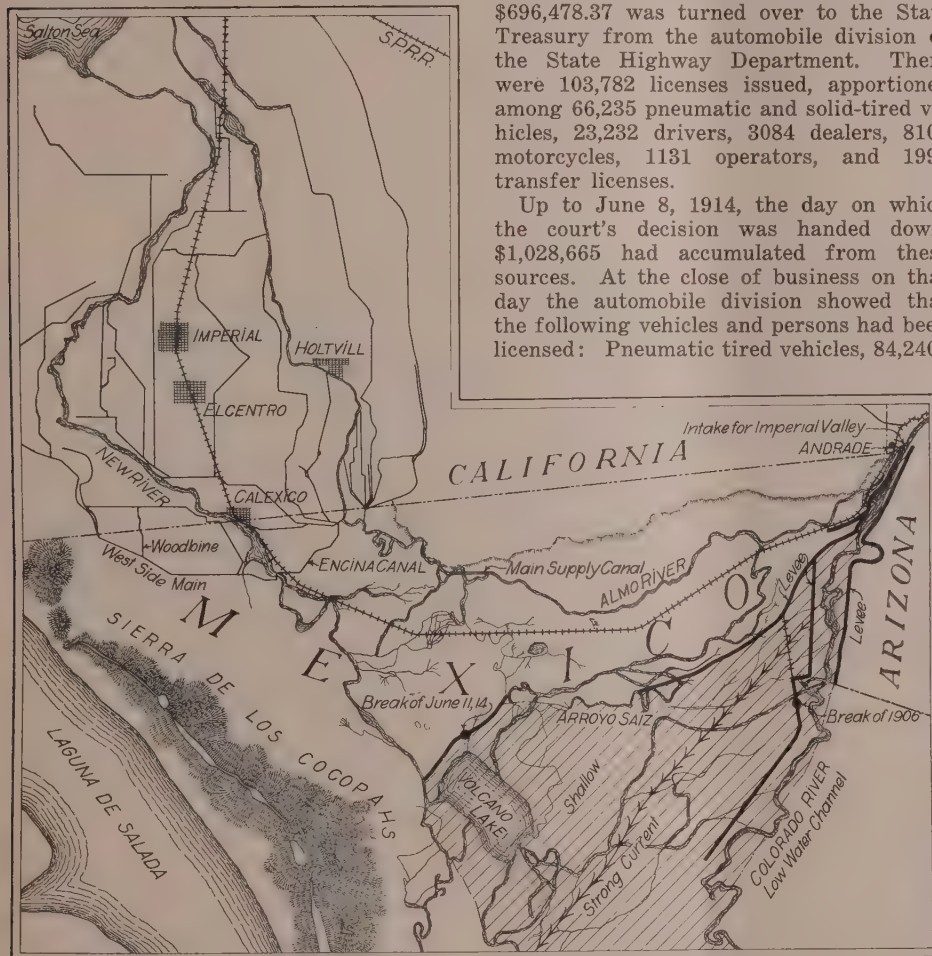
Meanwhile the river spread over vast areas of desert land southeast of Volcano Lake, known as the Colorado delta, and gradually encroached on territory usually well above water level. Funds for emergency work in strengthening Volcano Lake and Saiz levees were raised at various points in the valley and all men and teams that could be drafted into service were



METHOD OF PROTECTION BY SAND BAGS

ures were reported in this levee, although reports of two weakened sections about 6 mi. east of the present break were received June 17. All the levees were well saturated by that time and the situation would be serious if higher water or long-continued floods were expected, but reports received June 17 from several gages indicated a falling river and a lessening of the strain at all threatened points.

On June 19 the overflow of Volcano Lake reached Encina flume on its way to Salton Sea via New River, but there had been ample time to protect the flume and it stood safely. The flow in the old channel of the New River at this point reached its crest



IMPERIAL VALLEY IRRIGATION SYSTEM AND LOCATION OF LEVEE BREAKS

on June 20. On this date the water in Volcano Lake had fallen about 4 ft. and the flow through the break was cut down to one-quarter the initial volume. On June 24 the water level had fallen sufficiently to warrant the sending of a crew to repair the levee break under normal working conditions.

The attention of residents of the valley then turned from protection to flood prevention. A mass meeting was called for June 27 in El Centro, where it was proposed to consider asking an appropriation of \$2,000,000 from Congress to make certain improvements along the delta bed of the Colorado for the purpose of avoiding future flood dangers to Imperial Valley. The problem of controlling floods in the river was also announced open for debate, and it was suggested that if it were generally considered wise to ask an appropriation for this purpose at the present time a delegation should be appointed to appear before Congress.

Pennsylvania Motor-License Data

PENNSYLVANIA'S highway difficulties, resulting from the defeat of the proposed \$50,000,000 bond issue of last fall, as well as from the delay occasioned by judicial disagreement over the act appropriating motor-license fees for maintenance purposes, seem to have been relieved by the decision of the Dauphin County court releasing some of the moneys of the latter fund. This decision was noted in the Current News section of this journal on June 20.

Statistics showing the growth of these receipts have been received from the State Highway Department. On June 7, 1913, \$696,478.37 was turned over to the State Treasury from the automobile division of the State Highway Department. There were 103,782 licenses issued, apportioned among 66,235 pneumatic and solid-tired vehicles, 23,232 drivers, 3084 dealers, 8101 motorcycles, 1131 operators, and 1999 transfer licenses.

Up to June 8, 1914, the day on which the court's decision was handed down, \$1,028,665 had accumulated from these sources. At the close of business on that day the automobile division showed that the following vehicles and persons had been licensed: Pneumatic tired vehicles, 84,240;

solid tired vehicles, 5280; tractors, 402; trailers, 132; motorcycles, 11,430; drivers, 22,620; dealers, 3170, and operators, 15,833. There were in addition 2230 transfers, bringing the total to 145,434 licenses issued.

It will be seen that the returns for the current year are nearly 50 per cent greater than those of the previous year, and that the total number of licenses is about 40 per cent greater. Unless a further appeal ties up this \$1,000,000 fund, the program of putting the 9000 miles of road of the Pennsylvania system in repair will at once be started upon and carried out with all possible expedition.

PANAMA TOLL EARNINGS for the last part of May, dating from the first passage of commercial barges on May 18, were \$7356.12, according to the "Canal Record." This was the amount collected on 6130.1 tons.

Contraction and Expansion in Reinforced-Concrete Building

Experiments Demonstrate That Houses Expand and Contract More at the Top Than at the Bottom in Cold Weather

IN order to determine the effect of temperature upon a new building recently constructed in Cambridge, Mass., the Aberthaw Construction Company had Professor Howard, of the Massachusetts Institute of Technology, make some carefully standardized measurements of the Gray & Davis five-story reinforced-concrete factory, erected by them in 1913 from designs of Monks & Johnson, of Boston. The building is about 381 x 61 ft., the floors being of the flat-slab type. The outside is embellished with a tapestry brick veneer on corner bays, and also on curtain walls below the windows above the first floor.

The first measurement, made on a sunny morning—Nov. 7, 1913—showed a temperature on the ground in front of the building of about 70 deg. Fahr., while that on the roof, where the upper measurements were made, was about 57 deg. Fahr., being in the shade of the parapet wall. Points for measurement were established at the corners of the building by round-headed brass screws set into lead expansion shields and well anchored into the concrete wall. Intermediate points, established by stakes driven into the ground at approximately 100 ft. apart, were on the same level as the two end points and exactly in line with them.

AVERAGE OF THREE MEASUREMENTS

Measurements were made three times to obtain averages, and the temperatures taken by three standardized thermometers, one at each end and one at mid-length. After making all corrections to the steel tape used, the length was found to be 382.559 ft. at a mean temperature of 69.8 deg. Fahr.

The measurements in the upper part of the building, made from the roof, were located about 3 ft. above the roof level and were set in the same way as those in the bays. Three separate measurements were made here also, the final length being found to be 379.437 ft. at 56.9 deg. Fahr.

On Feb. 12, 1914—a cold day following several other cold days—three measurements at the base gave an average of 382.552 ft. at an average of 17.4 deg. Fahr. Three measurements on the roof gave a mean length of 379.377 ft. at a mean temperature of 6.2 deg. Fahr. These measurements seem to indicate that the upper part of the building contracted 0.06 ft. in a range of 50.7 deg. Fahr.; the base line contracted 0.007 ft. in a range of 52.4 deg. Fahr. It is intended to repeat these measurements on a hot day in the summer to further verify the figures already determined.

In addition to direct measurements, vertical lines were established between the bottom and top of the building. The top point at the west end of the building was found on Feb. 12 to have moved east 0.02 ft. The top at the other end of the building was found to have moved west 0.026 ft. Three intermediate points all moved west in amounts varying from 0.01 to 0.024 ft. This bears out the generally accepted idea that a building contracts more at the top than at the bottom in cold weather, and correspondingly expands more at the top than at the bottom in hot weather.

Tests of San Francisco Garbage Incinerator

Clinker Handling Machinery Being Redesigned to Care for Tin Cans

TIN cans in the clinker have prevented the successful operation of the Islais Creek garbage incinerator in San Francisco. M. M. O'Shaughnessy, city engineer, in a recent report of progress makes the following comments after detailing the history of the plant since 1908, when the bond issue of \$1,000,000 was approved by popular vote.

On Aug. 28, 1913, the Power Specialty Company commenced testing the Islais Creek incinerator and continued testing until Oct. 14, 1913. During this period 947.3 tons of garbage were burned. During these tests it developed that the grab bucket which had been furnished for the purpose of handling garbage between the garbage storage pit and incinerator furnaces was not entirely satisfactory and that the bucket elevator which had been provided for handling crushed clinker from the clinker crusher to the clinker storage bins was not suitable for the purpose. On Oct. 14, 1913, the plant was shut down for the purpose of installing a new grab bucket and bucket elevator.

On Dec. 24, 1913, after 26 tons of garbage had been delivered, the scavengers declined to deliver any more garbage until the road to the incinerator should be placed in a passable condition. On Jan. 19, 1914, the road had been repaired and the burning of garbage was again commenced and continued until Feb. 27, during which period 1070.9 tons of garbage were consumed.

UNSATISFACTORY HANDLING OF ASHES

The operation of the incinerator during this test showed that the machinery for handling the ashes and clinker resulting from the burning of the garbage was unsatisfactory and after numerous experiments the contractors decided to give up the attempt to make this machinery satisfactory and to redesign the clinker handling portion of the plant.

At a recent conference the contractors stated that they could have the plant ready for operation again about July 1. The engineers of the Department of Public Works are of the opinion, however, that a somewhat longer time will be required to make the necessary alterations and to not expect the plant to be ready for further trial before the first of August. It is but fair to the contractor to state that there does not appear to be any serious difficulty in burning garbage in a manner which is entirely satisfactory and without the emission of any considerable quantity of smoke from the chimney. The difficulty up to the present time has been in handling the resulting ashes and clinker. These contain a large quantity of tin cans which have prevented the successful operation of the clinker-handling machinery. This clinker-handling machinery is a new departure in garbage disposal and one which has not been experimented with to any considerable extent by any other city. It was adopted at the advice of Rudolf Hering, the consulting engineer under whose advice the specifications were prepared, with the idea of minimizing the cost of operating the incinerator. While it cannot be stated that the method of handling clinker which is now being installed will be successful until it has been tried, Mr. O'Shaughnessy can

see no reason to doubt that the plant can ultimately be made to comply with the requirements of the specifications in every particular.

In reference to the North Beach incinerator, it is not proposed to proceed with its construction until it shall be proven by actual operation that the plant upon which experiments are now in progress can be made to meet fully the requirements of the specifications.

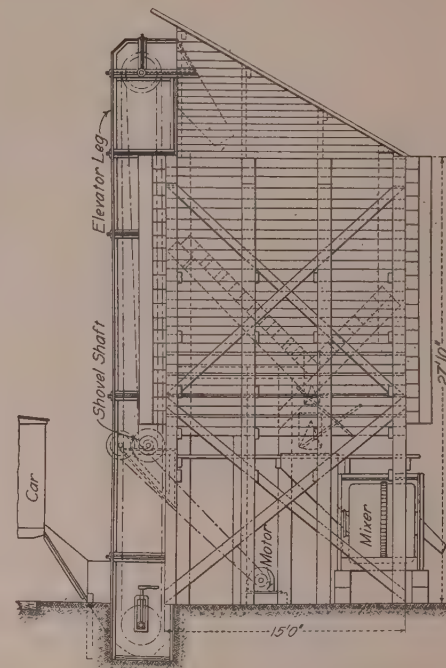
A Bulk Cement-Concrete Plant

Application of Grain-Handling Methods in Building Power Station in Chicago

GRAIN-UNLOADING methods are used to handle bulk cement at the plant for mixing concrete used in duplicating the Northwest power station of the Commonwealth Edison Company in Chicago. The concrete plant comprises elevated hoppers for sand, cement and broken stone, a bucket elevator to lift the cement, a grain unloader outfit for the cement, a derrick for unloading sand and gravel and a motor-driven 1-yd. Marsh-Capron mixer.

Hoppers for the sand and stone have 45-deg. sloping bottoms covered with galvanized sheet metal, and the central bin for cement is lined with tongued and grooved yellow pine flooring. The cement bin is housed in and is covered with a corrugated iron roof. Discharge from the three hoppers is through hand-operated gates in wooden chutes to a measuring hopper just over the mixer. The cement is gaged in a vertical steel portion of the central chute, in the sides of which $\frac{1}{8}$ -in. holes are drilled to indicate the cement wanted for the various kinds of mixtures desired. One man controls all the aggregate levers, the discharge to the mixer and the water required. A canvas apron is drawn over the charging hopper when the cement is dropped. With this precaution little dust was noted by a representative of this journal standing within 4 ft. of the hopper. Concrete of torpedo sand, broken stone and Universal Portland cement was turned out at the rate of 40 cu. yd. per hour and hauled to place in 6-cu. ft. Sterling buggies.

About 300 bbl. of cement per hour can



BULK CEMENT CONCRETE PLANT

be elevated from the boot to the 1400-cu. ft. storage bin by the elevator, which has 6 x 6 x 12-in. buckets operated by a 15-hp Crocker-Wheeler motor. Cement is removed from the cars in exactly the same manner as grain is unloaded at terminal elevators. A small steel scraper, about 2 ft. wide, held by two men, is dragged to the ends of the car and a small amount of slack given to the pulling rope, a movement which throws the winding drum into gear. The drum winds up until the scraper is near the center of the car door, when it automatically stops.

NO UNPLEASANT DUST

The cement falls into the boot of the elevator through a flared wooden chute with side boards inclined at the top to confine the cement. In walking over the compacted cement in the car one sunk into it about 1 in. and the dust raised in handling was little if any more disagreeable than that raised in unloading oats or coal.

Unloading of sand and gravel was accomplished by a Kiesler 1-yd. clamshell suspended from an 80-ft. boom and operated by a double-drum Thomas hoist driven by a 50-hp Northern motor. A third $\frac{5}{8}$ -in. Hercules line for holding the bucket ran to a braked drum. A $\frac{3}{8}$ -in. line on the same drum ran to a 300-lb. counterweight suspended from a leg of the derrick to keep the holding line taut at all times. With this equipment a car could be unloaded in forty-five minutes.

The Thompson-Starrett Company is the contractor for the Commonwealth Edison Company and the Dodge Manufacturing Company furnished the elevator, cement unloader and chutes for the mixer outfit. Holabird & Roche are the architects.



UNLOADING BULK CEMENT FROM CAR

GROSS OPERATING REVENUES for April on the large railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were \$1021 per mile, a decrease of \$44 over April, 1913. Operating expenses were \$763 per mile, a decrease of \$40. Hence the net operating revenue was \$258 per mile, a decrease of \$4. The operating ratio was 74.7, as compared with 75.4 in April, 1913.

Replacing Williamsburg Bridge Pins

The 10-Inch Main Chord Pins Were Collapsed and Removed, Holes Counterbored and 13-Inch Pins Inserted without Shoring the Spans

THE \$750,000 improvements on the main structure of the Williamsburg Bridge across the East River, New York, which were commenced about three years ago, have just been essentially completed by the substitution of four 13-in. nickel-steel pins for the former 10-in. carbon-steel pins in the bottom chords of the trusses. This hazardous and extremely difficult work had no precedent for size, rapidity and method. The most important features involved were the maintenance in position of the truss members while disconnected, the removal of the highly stressed and rusted old pins, the scientifically accurate measurements and readjustment of stresses in the members, and the design and operation of the high-speed special boring machine.

In order to develop the potential capacity

at each end of each main truss. The new members and reinforcement comprised in this work are indicated by heavy lines in the elevation of the south trusses at the Manhattan end of the bridge where the unchanged old members are shown by light lines. The effect of the improvements was to change the wind system from a continuous girder with six points of support to one with four points of support. Under the assumptions made, which were much lower than usual, the wind stresses from the 1600-ft. suspended span which were transmitted to the adjacent end spans developed excessive stresses in the chords of the latter.

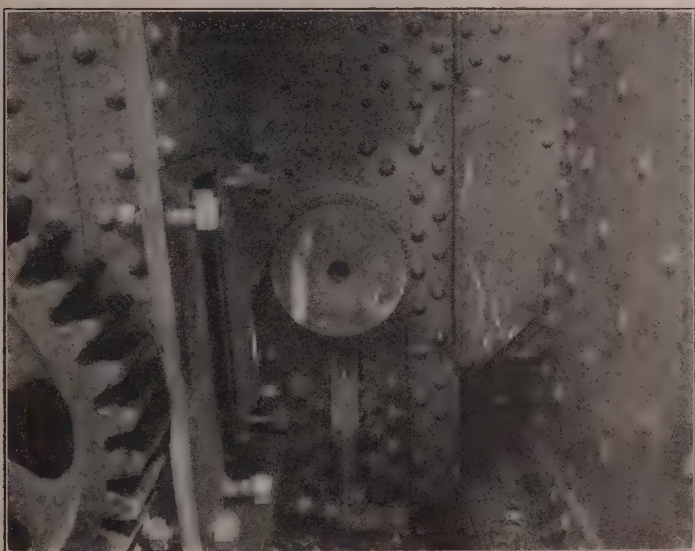
These stresses were not terminated at the main towers but were transmitted beyond the rocker bent supports at L 30 to

and therefore cannot be dispensed with. To preserve it the size of the pin at L 30 was increased and new members L 30-U 29 and U 29-30 were added and a new point of support for the suspended span reaction was provided at U 29 vertically above L 29, thus shifting the position without changing the amount of the moment.

DIFFICULTIES ENCOUNTERED

Advantage was taken of the difference in the distances between the centers of stiffening trusses and shore span trusses that permitted them to telescope at this point, and a transverse truss A was erected above the top chord and supported on permanent wedges on the overhang of the stiffening trusses, and from it span 18-29 was suspended. By means of these wedges the weight of the connecting span 18-29 was transferred from L 29 to U 29, relieving the stress on pin L 29 and permitting it to be removed.

The replacement of the old carbon-steel pin 28 in. long at L 29 by a new nickel-



NEW 13-INCH NICKEL-STEEL PIN IN POSITION



ENLARGING PIN HOLE TO 13-INCH DIAMETER

of this six-track, double-deck bridge, built about seventeen years ago and described in the then current issues of the Engineering Record, and to reinforce the main and shore spans, improvements were undertaken which involved a modification of the wind system, reinforcement of the trusses and the provision of intermediate supports between the original towers. Other changes were made in the main towers as illustrated and described in the Engineering Record of Sept. 16, Oct. 7, Oct. 21, 1911, May 23, 1908, and Aug. 21, 1909, on pages 321, 413, 479, 658 and 206 respectively. The last important operations have been successfully completed by the substitution of four nickel-steel lower chord pins for the old carbon-steel pins of smaller diameter in the same position. This, together with the other work done, increases what was formerly the capacity of the bridge from 8000 lb. to 16,000 lb. live load per linear foot for the end spans, provides for traffic not originally contemplated in the design of the bridge, and raises the general efficiency from the standard adopted originally to that now required for the great advance in service that has been developed.

NECESSITY FOR NEW PINS

The improvement in the shore spans involved four identical sets of operations, one

supports at the new towers 20, where they are transmitted through the towers to their caisson foundations. The old end spans cantilevered beyond their supports at L 15 on the old tower, about 60 ft. to the points L 18, and after the erection of the new tower 20 the truss 29-18 also developed a cantilever arm 18-20 about 40 ft. long.

The 9-in. pin L 18 thus became unnecessary for transferring vertical loads and was replaced by a 7½-in. pin fitted loosely in the 9-in. hole to insure the disconnection of the trusses in all directions, and at the same time to serve as a stopper for expansion movements transmitted to the anchorage, and to limit the longitudinal motion. The end truss 18-0 is strengthened by the new tower at L 10 and in all cases the new wind systems were designed to conform to the new points of support.

It was found that the members L 29-30, L 30-U 30 and L 29-U 30 would be overstressed and that the stresses in pin L 29 would be inadmissibly excessive. These stresses could not be relieved by the erection of a new tower at L 29 because the cantilever arm L 30-29 of the suspended-span stiffening truss is heavily loaded by the approach span 20-29 (originally 18-29), which affords a countermoment. This countermoment forms part of the original design of the main span stiffening trusses

steel pin 40 in. long to receive an additional member L 28-29, involved the enlargement of the original pin-hole from 10 to 13 in. in diameter. This required the removal of the old pin in such a manner that subsequent displacement of the various members assembled there should be prevented. To accomplish this the adjustment wedges had to be operated so as to accurately develop the exact stress required in the new member L 30-U 29, equal to the stress it was desired to relieve in the old member L 29-U 30.

These stresses were accurately measured and the operations frequently checked by extensometer measurements made not only for this but for other portions of the improvement work by the courtesy and co-operation of the United States Bureau of Standards. In each of the two members, L 29-U 30 which was to be released, and U 29-L 30 which was to receive equivalent loads, four to six sets of readings of five and six extensometer measurements were taken during the progress of the work and showed changes in unit stresses of from 10,000 to 12,000 lb.

TEMPORARY TRUSS MEMBERS

Continuity of the trusses was secured and the possible displacement of the members engaging pin L 29 was prevented by



OLD PIN COLLAPSED AND REPLACED

the addition of temporary members before the removal of the old pin L 29. Longitudinal displacement was prevented by tension members L 29-30 and U 29-30, by compression members U 29-30 and by wedges at L 29 which were driven in the clearance between the offset ends of the lower chords L 29-30 and L 29-28. Vertical displacement and the deflection of the cantilever arm were prevented by solid-web flange brackets and stiffened tie plates bolted to the members converging at L 29, to hold them rigidly together.

The compound top-chord member U 29-30 was slightly inclined from the horizontal and consisted of a wedged strut engaging the transverse girder A and the top chord, combined with a double yoke tie made of two pairs of screw rods bearing on end saddle pieces engaging the transverse girder A and the top chord as shown in the accompanying details. The bottom chord tie L 28-30 consisted of a pair of horizontal screw rods engaging bearings riveted to the old bottom chords. Provision for bottom chord compression was made by shims and pairs of vertical cast-steel wedges inserted between the ends of the chord section between L 29 and L 28. The other temporary members, at L 29, consisted of triangular brackets bolted in the angle between bottom chords and inclined posts and heavy horizontal ties bolted across the faces of the vertical and inclined posts, the different pieces together acting in the manner of gusset plates tending to transform the pin-connection to a fixed connection.

CHANGING PINS

Although provision had been made for safely transmitting the dead-load stresses while the joint at L 29 was disconnected, live loads, temperature stresses and vibration tending to produce relative displacement in the members at this point might cause serious trouble and it was necessary to limit the period during which the pin was removed to the shortest time possible and to select the occasion when traffic could be suspended with the least inconvenience and where there was the least probability of temperature changing.

The time for the actual pin removal was therefore fixed soon after midnight, when traffic could be temporarily suspended with the least inconvenience and the temperature was practically constant. An efficient high-speed machine was designed by the engineers of the bridge department and of the contractor, a full-size fac-simile model of the joint was made, and the hole in it was bored out by the machine installed in the shop, satisfactorily demonstrating its operation before the work on the bridge was commenced.

The pin was located at about the level of

the lower floor of the bridge and clearance for changing it was provided by removing a portion of the floor of the roadway outside the truss and cutting away part of the roadway floorbeam bracket connected to the vertical post L 29-U 29. Two horizontal brackets were bolted to the outer face of the post just above and below the pin-hole, and their extremities were connected by a vertical post on which the boring machine was mounted. An arrangement of slotted holes and wedges provided universal adjustment by which the position of the vertical post and consequently of the machine could be fixed with great accuracy and the machine was installed and approximately adjusted and the temporary top and bottom chord members were connected in the day time while ordinary traffic was in progress.

Attempts to drive out the old pin were entirely unsuccessful and it was found to be so badly rusted and jammed in position that a $2\frac{1}{2}$ -in. horizontal bolt tapped into the center hole in the pin was broken in an attempt to pull out the pin by screwing a nut on the bolt. Finally the boring machine was set up in position and a $1\frac{15}{16}$ -in. twist drill bit set in the end of the boring bar and operated to drill two holes through the pin on each side of and parallel to the $1\frac{1}{2}$ -in. axial hole originally made in the pin.

The partitions $\frac{1}{8}$ in. thick left between these holes were broken off by special tools having tapered shoulders which sheared off

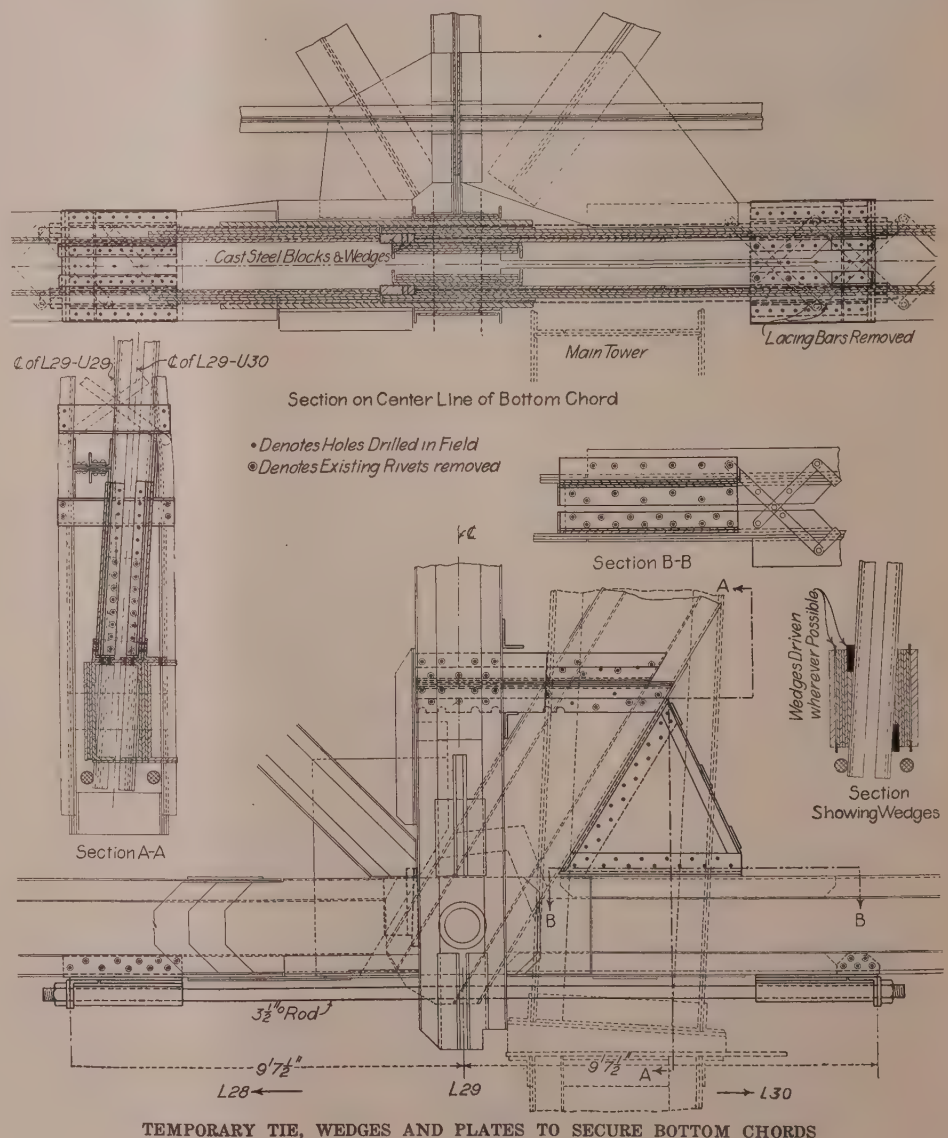
the metal as the bars were driven through the holes by sledge hammers. About 15 min. was the minimum of time required to break out one of these walls 28 in. long and about 5 hr. to drill each of the holes which were made with bits successively 12, 20 and 30 in. long on account of lack of clearance for handling the long bits in the first place.

INSPECTION OF PIN HOLES

After the drilling and cutting was completed the pins were easily collapsed and removed in halves and the holes were left open for about 2 hr. for thorough inspection and for the more important purpose of affording abundant time for the released members to take up any elastic after-effect which might be due to the release of stresses in them.

Then the halves of the pins were replaced and tapered plugs were driven between them at the ends to restore the pins to service for several hours while the bridge was under traffic until it was time for beginning operations for boring the enlarged holes.

After the suspension of traffic the old pin was again removed, the boring bar inserted in the machine, the final adjustments perfected and the hole enlarged from 10 to 13 in. in a minimum of about 57 min. net boring time. A finishing cut was then made in about the same time having a diameter between $1\frac{1}{32}$ and $3\frac{3}{64}$ in. greater than that of the new pin. The pin was swung to



TEMPORARY TIE, WEDGES AND PLATES TO SECURE BOTTOM CHORDS

position by a differential hoist and driven home. The hole was cut through a total thickness of about 24 in. of metal, accomplishing the removal of about 1300 cu. in. of steel in less than one hour. The final cut was found perfectly true and polished and indicated no movement whatever of the different members assembled together. The first cut was also smooth and true and would have sufficed without a finishing cut if the latter had not been provided for. The machine was driven through a silent Morse chain from a 35-hp C & C electric motor installed on the bridge floor and operated by a 220-volt current.

The work was done under the direction of the Department of Bridges; F. J. H. Kracke is commissioner; Alexander Johnson, chief engineer; Austin Lord Bowman, consulting engineer; L. S. Moisseiff, engineer of design; Y. R. Geoghan, assistant engineer in charge in field; I. Delson, assistant engineer in charge of structural details, and Martin Joachimson, assistant engineer in charge of boring machine design.

The method of securing the members at panel point L 29 against motion, and the method and special machine for enlarging the pinhole were designed by O. E. Hovey, retained as consulting engineer by the Snare & Triest Company, which executed the entire work of strengthening the bridge and its approaches.

Moving a Railroad Station on Flat Cars

By L. W. DUFFEE

Locating Engineer, New Orleans, Mobile & Chicago Railroad

WHEN the Gulf & Chicago Railway Company built a standard-gage railroad through north Mississippi it took over an existing narrow-gage line then operating between Pontotoc, Miss., and Middleton, Tenn. The southern terminus at Pontotoc was in a deep hollow below the town and required such expensive construction below that, instead of connecting the new line at the end of the old one, the new line, by agreement with the citizens, was joined to the old one about a mile above the end, but still passed within the corporate limits of the town. A station was established on the new line and the old one was abandoned. The mile of the old line, however, which had now become a spur, was standardized and used as an industry track.

Some of the dissatisfied citizens, however, instigated a suit against the company to compel it to use this old track as its main line, and after about five years of litigation they succeeded in their suit. The depot building, a serviceable wooden structure, 24 x 110 ft. in dimensions, had to be removed, and to save the expense and damage



MOVING A RAILROAD STATION

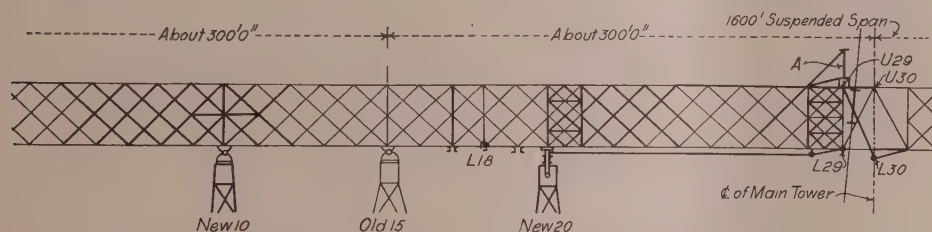
of tearing it down and rebuilding it, it was decided to move it bodily from one site to the other on flat cars. It had to be pulled out of a side track, up the old main line for over half a mile, then shoved backward a mile down the spur to the new site.

How It Was Done

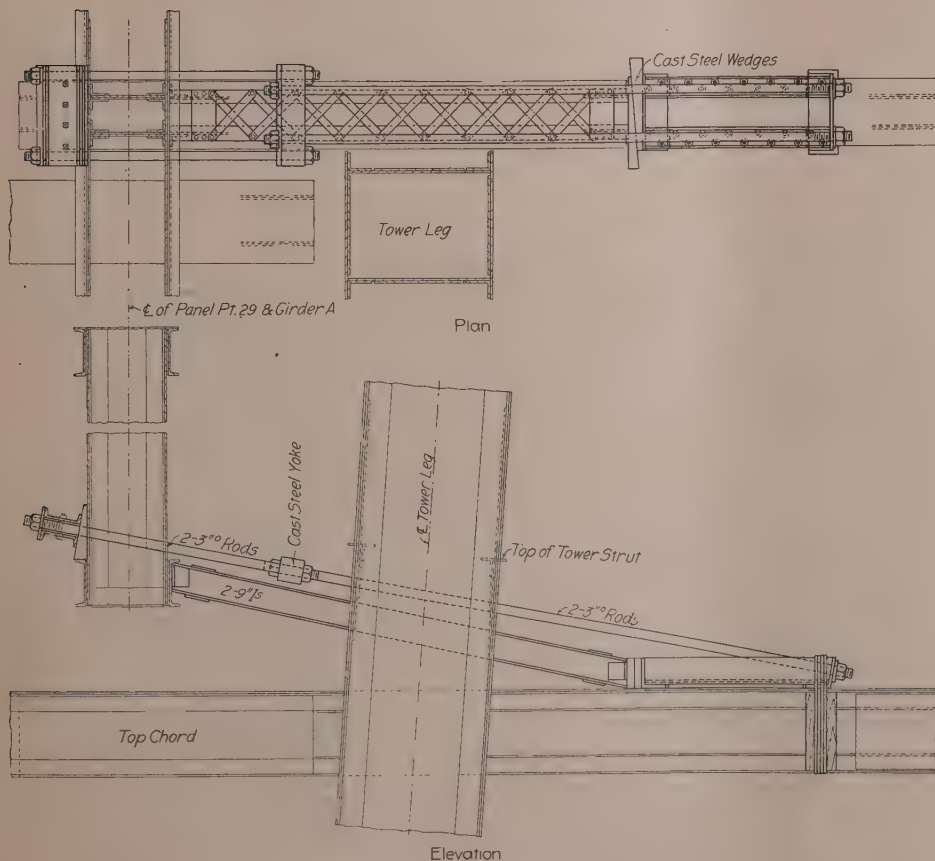
The building was first dismantled of its movable fixtures, adjoining platforms and baseboards. It was then jacked up and 7 x 16-in. old bridge stringers were placed under it, crosswise. The jacking was continued to a height of about 5 ft., cribbing with crossties and other timbers on the edges, and then a track was built underneath the center line of the structure longitudinally. The main-line track was cut, swung over and joined up to the house track and three flat cars were run under the building. The jacks were then let down and the cribbing was removed at the same time. One idler car was attached in front and the locomotive pulled the building out. Ropes were attached to the top of the roof and workmen walked alongside, ready to give a steadying hand should there be a tendency to tilt. This proved totally unnecessary, however, as the structure remained steady throughout the trip. There were several curves of at least 4 deg. on the route, and at that time there were reciprocating 1½ to 2 per cent grades on the old spur track. All of these were negotiated with little danger or trouble. Except for the delays caused by widening narrow cuts, etc., the time consumed in the movement was only about two hours, and so successfully was the handling done that not a single window or a single brick of the chimney-flues was broken or misplaced. The depot has served its purpose well ever since in its new location.

L. C. Johnson, bridge foreman, was in direct charge of the work. The writer was then resident engineer of maintenance. The road is now the New Orleans, Mobile & Chicago.

AN ANTI-MOSQUITO CAMPAIGN in Philadelphia, carried on in 1912 and 1913, is described in the report for 1913 of the Bureau of Highways and Street Cleaning. In addition to educational work, activities consisted principally in draining the stagnant pools, cleaning ditches and sprinkling oil over the breeding places in the lowlands in South and West Philadelphia. This was also done with the stagnant water on vacant lots and sewer catch basins, special attention being given to places in the neighborhood of schools and hospitals. One barrel of insecticide, 22 barrels of fuel oil, and 121 barrels of kerosene oil—144 barrels of oil in all—were used. A total of 583 pools and 35,758 sewer inlets were treated.



TRUSS DIAGRAM, SHOWING LOCATION OF NEW PIN AND NEW MEMBERS



TEMPORARY STRUT, WEDGES AND TIE TO SECURE TOP CHORD

How the Ancients Would Have Controlled the Mississippi and Its Tributaries

Abstract of Paper by Sir William Willcocks Read May 13
Before Engineers' Society of Western Pennsylvania—Part II

THE flood situation at Pittsburgh was the subject of the latter part of Sir William Willcocks' paper, "How the Ancients Would Have Controlled the Mississippi and Its Tributaries," read May 13 before the Engineers' Society of Western Pennsylvania and printed in the March "Proceedings" of that society. The first part of the lecture, referring to Mississippi River regulation, was printed in the Engineering Record of June 27, page 723. The abstract of the second part follows.

I now come to Pittsburgh. We have here the same problem as on the Mississippi but in a smaller way. The only difference is that on the Mississippi the man on the right bank worries because the man on the left bank puts up a levee. Here you have the satisfaction of knowing that you have created your own difficulties. You have two rivers, the Allegheny and Monongahela, with only 20,000 sq. miles drainage basin. These rivers are quite ordinary rivers, but they have for short intervals of time most extraordinary floods. The maximum floods they carry are just about what the Tigris and Euphrates carry when they meet. Those rivers have it for months and you have it only for a few hours. But a few hours of water flowing through your house is almost as big a worry as having it for a week.

ALLEGHENY AND MONONGAHELA

These two rivers as they come down do not have big reservoirs as the Mississippi has lower down, but they had very fine reservoirs at one time. First of all there were the overflows in the valleys themselves. Then going back in every direction were the side valleys, wide in places and narrow in others. With a river that comes down in high flood for months they would have been of no use, but with a river that comes down only for a few hours or days the valleys gave ample elbow room, and by the time the flood got down to the Ohio River all its force had been spent in filling up these side openings and before it had time to fill them all full the storm had ceased and the flood had passed.

Now what have you done in these years? You have deprived the river of all elbow room. I saw a bridge where the river was 1300 ft. wide and to-day it is only 650 ft. Nearly half the river has been filled up with factories, with railroads, and with every kind of industrial institution. Then you have erected numerous bridges, not with piers one in front of the other, but all irritating the river and holding up the water in every way they can. Now when the river comes, instead of having elbow room as it had in the old days, it finds itself contracted within two solid walls. And if you calculate the height it has come up above the old floods you will find it has made up in height for the area you yourselves have taken away from it on both sides.

PITTSBURGH AS COMPARED WITH ROME

As far as I can see you have no more difficult problem here than the city of Rome had where in the course of years the Tiber

had risen 10 ft. above the Aventine quarter. They spent many millions of money, but they bought all the houses on one side of the river and widened the channel about a third wider than it was, built two walls and raised the banks, and now the whole town is protected. It cost a great deal of money, but they had no one to appeal to but themselves to do it, and they did it. In Pittsburgh, too, a wall has been proposed. I speak under correction, but when I see the shingle and stuff on which you are founded I think a wall would not prevent water from coming up from underneath; but it would be easy to raise the streets on both sides of the river and then when the flood came it should not get across it, and whatever water seeped through into cellars might be pumped out over the banks. Whether reservoirs are made or whether they are not made, I think this street raising ought to be made on both sides straight away like Rome. If you do make reservoirs and you have a basin of 20,000 sq. miles, and your reservoirs cut off the water of 10,000 sq. miles, you still have 10,000 sq. miles this side of the reservoirs, and if you have a heavy downfall of rain on that it might bring down quite enough to worry you, especially if you had warm rain on top of snow. I think reservoirs ought to be made if they can be made, but whether they are or not the streets should be raised.

For navigation as I see it, there is no better plan than you have, with your weirs and locks, but you have an acid water which eats iron in an extraordinary way, and any kind of permanent weir which would not necessitate these iron structures that raise it temporarily would be a great gain. There are many places on your rivers where you could build permanent weirs of a height to suit low water navigation and the high water would flow over very freely. On the Nile we built permanent structures 9 ft. above bed level of the stream, which hold up 9 ft. of water in the summer time, and when the floods come you would not know there was anything in the river at all because when the river rises 30 ft. a 9-ft. obstruction does not count for anything.

CAPACITY OF RESERVOIRS

Still in an important city like Pittsburgh, in addition to whatever you do, something in the way of reservoirs ought to be done if it can be done. In a recent book which you have written on this reservoir question I see that the quantity of water you consider necessary to impound in these reservoirs seems to be in excess of what you need. In all the calculations it has been assumed that when the river rises its discharge increases up to its maximum gage. As a matter of fact it does just the opposite. When it is rising fast it has a great velocity and a great discharge, but when it comes to within 7 or 8 ft. of the top the velocity has begun to decrease and with it the discharge. On the Tigris, which jumps up and down very much like this, when the river gage is 15 ft. rising, the discharge is 180,000 sec. ft. When it has risen to 20 ft. and reached its maximum for that rise, its discharge is 120,000, and when it has

come down on the other side to 15 ft. the discharge is 90,000 sec.-ft. As in all these estimates you have allowed for an increasing discharge and not reduced by half for the falling gage, a much smaller quantity of water than you have assumed would suffice to shelter you from these hours of high flood which produce all the worry.

The difficulty here is that the same operation which made your soil very rich in coal has made it very bad for reservoirs. This horizontal sandstone and shale in alternating strata are considered the worst foundation for reservoirs of anything in the world. More accidents to big reservoirs have happened on it than any other. If the strata are inclined at a steep angle and you build your dam on it, it rests on the hard particles and the weak strata are more or less ignored. But if you have horizontal strata and you hold up water with a 150-ft. head, the water works its way through the shale and gradually undermines it; because horizontally it can do it very easily, and when it reaches a certain point the upper strata settle and the dam collapses.

FOUNDATIONS FIRST

In your book you show that you spent money on many things but not one penny to find out what your foundations are, and all the rest of it is worth nothing until you are sure of your foundation. You ought to spend some \$10,000 for drills and take two of the nearest sites and expose the foundation and see if you can build a dam there. If you find really good foundation your difficulties will be at an end. Your condition is such that if you had a high flood and a reservoir with 150-ft. head on the hills above you and it happened to breach and came on the top of the flood, all the disasters you know of to-day would be but child's play. And if you had two in the same valley and the upper one burst and came down on the lower one and the two came together you might open the early chapters of Genesis and begin reading about Noah's flood to comfort you. So of all the things that are necessary the first is to be sure. Reservoirs with good foundations up in the clouds are no use. Even if you could open and shut them it would be too slow coming on its way. They must be low down. I never saw such bad looking stuff for reservoirs, and I found that no one had bored down one foot to see. For when you have bad rock it is often necessary to go down 50 or 100 ft., and when the water flows through the dam you have got to make an apron down stream 100 yd. wide in order to protect the rock from the action of the water. You have two expenses, one a very expensive dam and the other a very expensive floor down stream to prevent it from being undermined. As far as reservoirs are concerned, if you had granite or steeply inclined crystallized limestone or any of the good rocks in which reservoirs are built, I would back your reservoir project against all the others. If ever the central government pays for the reservoirs it would be your certain duty in this town if a reservoir were built near here, to see that the foundation was good. Because rivers with rock suitable for foundation have been controlled, it does not necessarily follow that you can do the same if you have no suitable rock. If the reservoirs can be made, or if they cannot, the duty of raising the streets on both sides sufficiently high to protect the lower parts of the town is incumbent on you.

One-Story Street Railway Shops at Louisville

Concrete for Floors and Foundations Delivered by
140 Foot Tower

IN constructing three one-story fireproof \$250,000 repair shops for the Louisville Railway Company a 140-ft. tower was utilized almost entirely to deliver concrete for the floors and car pits. The buildings will be used for repairing rolling stock and ultimately for manufacturing cars. The new buildings house the paint, carpenter and machine shop divisions and have concrete floors unreinforced except for column footings, repair-pit floors, a storeroom floor, one basement and some balcony floors.

The side walls of the structures are of brick and the roof is of steel trusses covered with concrete slabs. No. 2 pavers were used for the walls, laid up with $\frac{3}{4}$ -in. cement mortar joints, rodded to bring out the blocks in bold relief.

The roof, 117,000 sq. ft. in area, is of sawtooth steel-truss construction, equipped with United steel sash and skylights, and for economy universal duplication of the steelwork for each panel and sawtooth was carried out. In construction the 2 x 6-in. wooden rafters were spaced on 3½-ft. centers with two lines of 2 x 6-in. timbers laid flat to act as forms. Upon the latter and across the steel purlins 26-gage Hy-Rib reinforcing was secured. A 2-in. concrete slab, of 1:2:4 mixture using $\frac{1}{2}$ -in. screened gravel, was put on next, and over this a tar-and-gravel roof was applied. When the roof had seasoned sufficiently the wooden rafters were removed and the under side of the reinforcing was coated with a $\frac{3}{4}$ -in. coat of cement plaster.

FLOOR SURFACING

Floor surface available in the three buildings amounts to 141,000 sq. ft., of which 25,000 sq. ft. in the machine shop were treated with Ferro-Fax hardener to render the floor dustproof and wearproof. The $\frac{3}{4}$ -in. top coat was made with 12 per cent of the compound and cement mixed before adding sand. After floating, a dry coat of the mixture, 1 compound to 1 cement, was sprinkled on and troweled to a smooth finish. This shop floor will receive the wear from the heavy machinery



SINGLE CONCRETING TOWER SERVING WIDELY EXTENDED CAR REPAIR SHOPS

employed in repairing car wheels and motors.

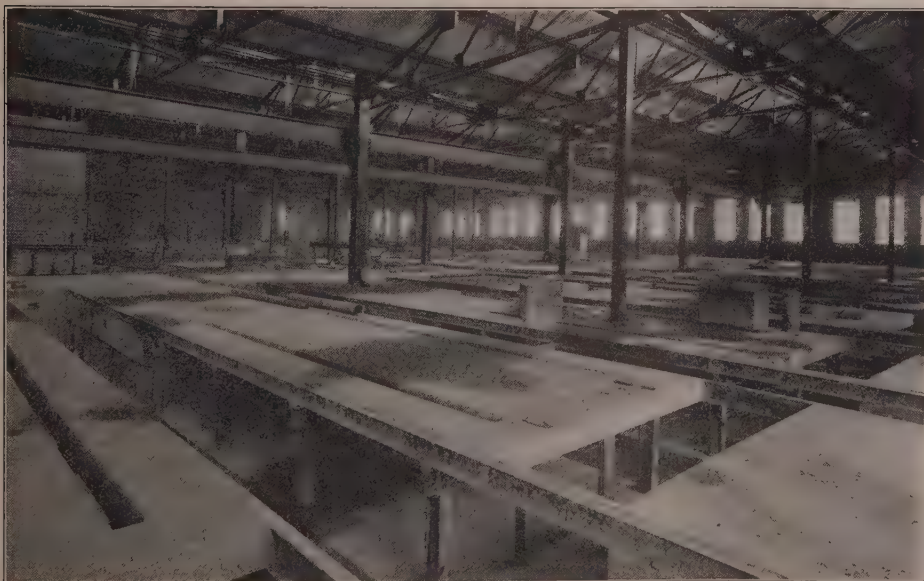
The arrangement of car-repair pits is such that hydraulic jacks operating through slots on the concrete slabs may raise the body of the car from the running gears and without undue blocking give plenty of headroom for the workmen. All pits are interconnected beneath the main floor, the under spaces being used also for conduits in which to run the heating pipes.

Spaces between the three buildings are occupied by Nichols transfer tables to reduce the space over that required for a system of track ladders. The $\frac{3}{4}$ -in. Smith mixer was located at the foot of the concrete tower between the machine shop and the carpenter shop, 30 ft. from a railroad siding. It was equipped with a $\frac{3}{4}$ -yd. Lakewood bucket operated by a Lidgerwood hoisting engine. Two auxiliary 40-ft. towers were erected, one at the south end of the machine shop and the other between the carpenter shop and paint shop. Semicircular chutes, 10 in. in diameter, were constructed in 8-ft. sections of No. 18 galvanized iron, suspended from $\frac{3}{4}$ -in. Roebling steel cables and fastened to them by cable clamps and lap links.

For operating this plant the usual crew consisted of a hoisting engineer, mixer en-

gineer, three men on gravel, one man on sand, one man on cement, one man dumping the mixer, a clean-out man on the main tower, and from five to six men handling the concrete, moving the chutes and grading the concrete for floors. Due to the small volume of concrete to be placed in any one division of the work, it was necessary to move the chutes a number of times. The greatest yardage was 130 cu. yd. for a stack foundation in one day of ten hours. While running 5-in. floors with this crew it was customary to place an average of 500 sq. ft. per day. Usually it took two or three finishers with two mortar men to finish this floor area. In running the roofs one sawtooth section was placed each day, approximately 7200 sq. ft., this slab being 2 in. thick.

The repair shops were designed for the Louisville Railway Company by J. B. Hutchings and E. T. Hutchings, architects, of Louisville, and were erected under the direction of T. H. Minary, assistant to the general manager, and John Zoll, master mechanic. The L. W. Hancock Company was the contractor, for whom C. W. Knipp was general superintendent.



TYPICAL STRUCTURAL DETAILS OF ROOF AND FLOORS OF LOUISVILLE SHOPS

COVERS FOR SPRINKLING FILTERS
Care required at the sewage-treatment plant in Aberdeen, S. Dak., on account of the severity of the winter weather. As described by W. G. Potter in a paper presented at the June 15 meeting of the Western Society of Engineers, concrete piers, 13 ft. apart, were built between the sprinkling nozzles and extended to a height of 6 in. above the surface of the crushed stone to form supports for a wooden framework. On the concrete piers 4 x 4-in. wooden posts were erected with 4 x 6-in. stringers between them. On this framework a temporary winter cover of 2-in. plank is laid. The plank cover only will be removed during the warm season, the framework being left in place, although this framework is so built as to be removable without drawing a nail. This roof is of a flat hip-roof construction, with 3-ft. rise to the center. All wood used on this was painted with a wood preservative before using. The sprinkling filter covers 0.68 acre; with the present normal flow of about 1,500,000 gal. per day it will have a loading of about 2,200,000 gal. per day per acre.

Who Is Responsible for Pavement Deterioration along Street Car Tracks?

Upon the Decision of the Lincoln Avenue Case, Pending in Chicago and Involving Contractors' Guarantees, Thousands of Dollars Depend

By P. E. GREEN
Consulting Engineer, Chicago

ONE of the most perplexing problems in modern city pavements is the construction and maintenance of a first-class pavement along street-railway tracks. In practically all cities this trouble is encountered, and it is a frequent cause for discussion in societies and the engineering world generally. In large cities poor paving abutting car tracks is one of the greatest points of criticism.

The city of Chicago has lately won an exceedingly important case in litigation on this point. The decision means hundreds of thousands of dollars to the city and to various contractors. It will undoubtedly be appealed and hence will not be finally decided for two or three years.

In order that the following discussion may be clear, the "brow pavement" is defined as that part of the paving area within a couple of feet and outside of the street-railway tracks. The "quarter point" or "quarter" is the point midway between the outer rail and the curb.

The writer from 1907 to 1909 was in general charge for the city of Chicago of the work described and during the litigation was retained to assist the city in its presentation of its case.

WOOD-BLOCK PAVEMENT

Lincoln Avenue is one of the principal secondary business streets of the North Side of Chicago. It is a diagonal street and accommodates a heavy traffic, both vehicular and street railway. It is paved with creosoted-wood blocks on a sand bed 1 in. in thickness and a 6-in. concrete foundation. The wood blocks are long-leaf yellow pine, treated with Kreodone creosote oil of a specific gravity of 1.08. The joints of the pavement when constructed were filled with tar and the blocks were laid in diagonal rows very close together. The pavement was constructed in three sections—the first mile, between Wrightwood Avenue and Belmont Avenue, in 1907; the second mile, between Belmont Avenue and Irving Park Boulevard, in 1908, and the third mile, between Irving Park Boulevard and Western Avenue, in 1909. The space between the rails and tracks is paved with granite block for the first two miles and with wood blocks in the third. The creosoted-wood block pavement is laid in rows of approximately 45 deg. to within 4 in. of the rail generally. Most of the brow has a single longitudinal block laid parallel with the rail. On the west side of the first mile, however, the diagonal rows extend to the edge of the rail. The contract price for the work, exclusive of the street-railway right-of-way, was about \$225,000.

The railway construction is what is known as "Type 3," as adopted by the board of supervising engineers which prescribes the street-railway construction of

Chicago. This type consists of a lower course of 8 in. of crushed stone upon which the ties and rails are laid. The ties and bottom of the rails are then covered and surrounded by 8 in. of concrete. On the top of the concrete is spread the sand bed, and the pavement is laid on this sand bed. In the first mile mentioned, in addition to this crushed stone, crushed cobbles were placed in the bottom of the trench made to receive the track construction, and the



BROKEN BROW OF PAVEMENT ALONG CAR TRACKS ON LINCOLN AVENUE, CHICAGO

whole was thoroughly rolled with an Iroquois 10-ton roller. Particular attention is called to this type of construction, as its ability to stand up under the traffic was a question of the problem discussed in the following paragraphs. The rails themselves were of the girder section and weighed 129 lb. per yard.

In longitudinal profile the street is exceedingly flat, there being only about 3 ft. difference in elevation in 3 miles. The roadway of Lincoln Avenue is 42 ft. wide from curb to curb. Since the railway right-of-way is 16 ft. wide, this means that the pavement is approximately 13 ft. wide on each side of the railway right-of-way.

TRAFFIC CENSUS

Traffic is heavier in the first mile, especially as regards the railway traffic, than in the second or third mile. This is because Lincoln Avenue is known as a through-route street and at the end of the first mile some of the cars turn off the avenue.

A census of the traffic taken between the hours of 7:30 a. m. and 10 p. m. is given in the table.

For the past four or five years the

street cars have been practically all of the large pay-as-you-enter type, weighing when loaded about 80,000 lb. Previous to that time cars of all sizes and types were used, with the heaviest weighing about 50,000 lb. loaded.

EXTENT OF DAMAGE

Within the past three years the condition of the brow in the first and second miles, and especially the first mile, has become very bad. The pavement for a distance of from 6 in. to 4 ft. from the rail has been broken down and dips below the top of the rails. Between the rails the granite blocks have also dropped down to a considerable extent, though not as badly as on the outside. In general appearance it would seem as if the entire right-of-way had been dropped from 1 to 2 in., with the resultant disintegration of

the pavement. At intervals humps or blisters were in evidence on the pavement, generally in the vicinity of the gutters. These humps were from 3 to 20 ft. in length and rose above the general surface of the pavement from 2 to 6 in. Adjoining such humps the surface of the pavement was invariably broken down and depressed.

After much correspondence between the proper city authorities and the contractor for the original work in the fall of 1911 and early part of 1912, the contracting company, one of the largest and most responsible in the city of Chicago, and a company which has had an irreproachable reputation, refused to make further repairs and was notified by the city that the city would use the 5-per cent reserve fund held back by them until the expiration of the guarantee period to make such repairs as the city deemed necessary. The contracting company then entered suit against the city for this reserve fund, amounting, approximately, to \$12,000, stating that it was their opinion that the damage had been caused by the settlement of the street-railway tracks. They stated that the railway construction was not strong enough to withstand the heavy cars now in use and which were not contemplated at the time the pavement was built.

It was recognized by both the city and the contractor that on account of the con-

CENSUS OF TRAFFIC BETWEEN 7:30 A. M. AND 10 P. M.

First mile—street cars.....	1041	Vehicular traffic.....	1500
Second mile—street cars.....	746	Vehicular traffic.....	1814
Third mile—street cars.....	457	Vehicular traffic.....	1010

dition of the pavement an emergency existed. If the pavement were not repaired at once it would certainly, within a few months, be entirely destroyed from curb to curb, and no matter what the result of the court proceedings a vastly larger loss would be sustained unless immediate repairs were made. An agreement was then entered into between the city and the contractor that the contractor should make the repairs at once and that the actual cost of the repairs should be deposited in escrow awaiting the final decision of the courts. In case the contractor lost, this money would revert to the city, and in case the city lost this amount and the reserve also would be returned to the contractor.

It was also recognized by both parties to the suit that the decision would be one of immense importance, for if the city lost, the guarantees of contracting companies on car-track streets would be worthless. Hence, the case has been bitterly fought, with a multitude of experts and near-experts on both sides.

REPAIRS

Repairs of the pavement were started immediately and the writer was commissioned by the city to make a thorough investigation and report as to the causes of the trouble. Very careful levels were taken, both of the track and the pavement, and an effort was made to connect these levels with the original grade level of the street-railway tracks. It was found, however, that the original levels had not been accurately tied to the standard benches and hence no reliable information could be obtained by this means as to whether or not the track had settled.

As the concrete was exposed on the outside of the rails for the purpose of making proper repairs, very accurate measurements were taken at frequent intervals to observe the actual contour of the foundation, and minute investigation was made as to the condition of the concrete immediately adjoining the track—in other words, along the brow. This concrete was almost universally found to be in most excellent condition as regards the material. It was sound and unbroken except that for about 20 per cent of the longitudinal distance and immediately adjoining the bottom of the rail it had become shattered. The same condition as to concrete was found between rails, though it was noted that only over ties was the concrete usually disturbed. This was the thinnest point of the concrete, it being only about 2 in. thick on the inside of the rails and 4 in. thick on the outside, the cause of the difference being accounted for by the character of the pavement. Between the rails the pavement consisted of 5-in. granite blocks on 2 in. of sand on the concrete foundation; on the outside the pavement consisted of 4-in. wood block on 1 in. of sand on the concrete foundation.

It was shown in the trial that the board of supervising engineers had designed the track in 1906 to carry the heavy double-track pay-as-you-enter cars now in use.

CONDITION OF FOUNDATION

The testimony of all the witnesses was universally to the effect that the concrete foundation was in excellent condition. The street-railway company testified that in very few cases had they found broken concrete. In the spring of 1913 they had repaired the pavement between their rails

and had shimmed their track whenever necessary. These shims consisted of iron plates from 1/32 to 1/2 in. thick, but by far the greater number used were of the smaller size, and only in very few cases were the 1/2-in. shims employed. Where these were used there had been cuts made in the pavement by the public-utility companies.

It was also brought out in the case by testimony of city employees and by the contractor that the concrete when originally laid had been surfaced to three stakes set across the half roadway between the track and the curb, one stake being set at the end of the ties, one at the quarter point and one at the gutter. No allegation was made by the city that the material or the thickness of the foundation was defective in any way. It was very clearly demonstrated, however, that the concrete midway between the brow and the gutter was almost universally from 1/4 to 1 in. higher than the concrete at the rails. In other words, either the track had gone down or the concrete had not been carefully laid to grade, since it was conclusively shown that there was a very distinct drop from a point about 4 ft. outside of the rail to the rail. It had also been clearly shown that the concrete was in excellent condition, that it was not at any time broken or shattered except for a distance of 2 or 3 in. adjoining the rail in about 20 per cent of the length of the street.

To further investigate the foundation, three large openings were made in the pavement entirely through the concrete to the subgrade and the thickness was very carefully measured. These holes, which were taken at distances apart of about 2000 ft. on alternate sides of the street, exposed the contour both of the top and bottom concrete. They showed, first, that the concrete was sound and unbroken; second, that at its thickest point, which was the high point of the surface, the concrete was fully 7 in. thick; third, that the bottom of the concrete foundation was below the theoretical bottom as shown in the original ordinance and plans, while the top was above the theoretical line established as the top of the foundation. Both the theoretical top and bottom were established for these points by assuming the present top of rail elevations to be at original grade.

THEORY OF CAUSE OF TROUBLE

From this thorough personal investigation it is believed by the writer that the railway tracks did not settle appreciably. After six years' use under heavy traffic the only work necessary to put the track in first-class line and grade was an occasional shim 1/16 in. thick. No decided depressions of the track were found. It is inconceivable that the track could settle uniformly from 1 to 2 in. without breaking the concrete around the ties and back of the rails and without badly distorting both line and grade.

The profile of the street is nearly level. Drainage in the gutters is formed by a succession of summits and inlets. At the summit the gutter was generally 4 in. below the grade of the rail and at the inlet about 10 in. below grade. The cross-section of the street is presumed to be an arc of a circle, but in reality is a parabola. The stakes at the quarter point were set a distance below grade of one-fourth of the total drop to the gutters—that is, at the

summits the drop from the grade of the track to the quarter point, 7 ft., was 1 in. and at inlets it was 2 1/2 in.

It is undeniable that at present the surface of the concrete midway between the quarter and the brow (half way between stakes as set) is from 1/4 to 1 in. above the concrete abutting the rails. Yet the concrete is sound and unbroken. When this condition exists any water getting between the blocks and the foundation cannot drain away through the sand bed to the sewer inlets in the gutter. Traffic pounding the blocks and street cars pounding the rails—all act as the plunger of a pump and the sand is forced up through the joints to the surface of the pavement and then blown away. In a short time the blocks of the brow pavement drop and then the wheeled traffic pushing and pounding on the distorted blocks, tilted toward the rails, gradually forces the sand back toward the curb, forming the large blisters previously described. Some of these blisters when opened showed a depth of 6 in. of sand at their high point.

WHY HIGH FOUNDATIONS?

It may be asked why the concrete foundations should be high between the stakes. The explanation is as follows: It will be remembered that the preceding paragraphs mentioned three openings made through the concrete foundation. These openings were made by the writer to test his theory as to the fundamental cause, and they did so very completely. These openings showed, first, that the top of the foundation concrete was 1 in. higher at a point 3 ft. from the rail than at the rail; second, that the bottom of the concrete foundation was either almost exactly at its theoretical location or below it—in other words, the rails had not gone down with respect to the bottom of the foundation or the subgrade; third, that the concrete was actually thicker than the 6 in. specified. In two of the three openings it was 7 in. thick at the high point. Hence the trouble would seem to be in the workmanship. But why? It is believed that the concrete spreaders on a street having such a flat profile and section kept the concrete high at the point in question. The cross-section is so flat at this point of the curve and the instructions are so urgent that there must not be any depressions in the base, that the men have instinctively gone to the other extreme and made it slightly higher. During construction it would pass unnoticed, for as soon as the concrete sets the sand bed is roughly spread on it in a street like this in order to protect it from street traffic using the railway right-of-way.

A similar condition will probably be found in many streets having car tracks. The resulting deterioration is the fault not of inferior design or material but of faulty drainage caused by faulty workmanship on the foundation. Where the drainage is perfect away from the track the pavement is perfect. This was fully shown on Lincoln Avenue. The inferior workmanship was not what is usually called such. It was an unconscious error, not a deliberate one.

THE REMEDY

The remedy is plain. Drainage must be perfect. If it is, there will be little trouble with any modern brow pavement, provided the street railway has a foundation at all adequate for its purposes. A dip in the

foundation toward the rails of $\frac{1}{4}$ to 1 in. in 3 ft. may seem a small thing to many engineers, but if no water is held in the sand bed there will be no hydraulic action caused by the traffic. It is not a question of whether or not a sand cushion or a mortar bed is placed under the blocks. A mortar bed under constant pounding will pulverize and the same action take place.

It is the old question of perfect drainage. Water is the great enemy of all street pavements. The more nearly the actual drainage conforms to the theoretical requirements, the more perfect the wearing surface will be and will remain under the heaviest traffic.

Improving the Water Supply of Galveston, Texas

Abstract of a Report by John B. Hawley, Consulting Engineer, Fort Worth, Texas

WATER supplying the 40,000 people of Galveston, Tex., is obtained from thirty-one artesian wells at Alta Loma, 18 miles from the city. The wells are sunk from 780 to 800 ft. into a layer of water-bearing gravel. For twelve years the water flowed by gravity from Alta Loma through the 30-in. cast-iron main into a 1,200,000 gal. receiving tank, whence it is pumped through the city mains. Recently pumps have become necessary to force the water through the supply main. By compressed air the water is forced into a concrete settling tank, 40 ft. in diameter and 25 ft. deep, from wells which are from 300 ft. to $1\frac{1}{2}$ miles away. Sand in the water settles out back of a brick partition in the tank 6 ft. high. Water then goes to a receiving tank of the same dimensions as the former one.

Recently John B. Hawley made an investigation of the water supply and extracts from his report follow.

As to the geology of the underground-water supply, Prof. Alexander Deussen, of the University of Texas and U. S. geologist for Texas, stated for Mr. Hawley that Galveston County is underlaid by a series of gravel deposits, which range in thickness from 50 to 200 ft. and dip toward the coast at a rate of about 35 ft. to the mile. At League City these gravels are entered at a depth of 525 ft. The depth of them regularly increases until beneath Galveston City a depth of 810 ft. is required to reach them. These gravels are very prolific water carriers and supply potable water over the whole of Galveston County, with the exception of a strip along the coast extending some 10 miles back. In this strip it is impossible to secure perfectly potable water at any depth. The strike of these water-bearing sands in Galveston County is approximately parallel to the coast, and Prof. Deussen does not consider that it would have made very much difference to have ranged these thirty-one wells over a distance of $2\frac{1}{2}$ miles on the strike line rather than on the north-south line.

However, states Mr. Hawley, a well near Alta Loma has been sunk to about 2000 ft. without developing more or better water, and the "water plane" on the strongest pumping is only 25 to 30 ft. below the surface. With proper care of the individual wells it will probably be many years before the "working-water plane" will be even 75 ft. down.

Some of the recommendations made for

increasing and bettering the system are the installation of a larger air-supply pipe to cut down friction losses, conservation of the condenser water, installation of a second 200-hp boiler, equipment of two 12-in. wells with centrifugal pumps, electric motors and an oil engine. The centrifugal machinery is estimated to operate at one-half the cost of the air lift. These recommendations are now being carried out under the direction of the water and sewer departments, of which A. M. Burgess is superintendent.

The two wells are estimated to furnish 2,000,000 gal. per day, and a like amount or more can be obtained by either the Imperial or the Corliss compressors at present. Much greater quantities are expected after the air piping is remodeled. With the Corliss compressor and the two wells 5,500,000 gal. should be obtained, a quantity nearly 1,000,000 gal. more than was pumped any day last August.

Building a Baseball Grandstand in Record Time

Work Rushed Through at Chicago's Latest Stadium, 1000 Tons of Steel Being Delivered and Erected in Seventeen Days

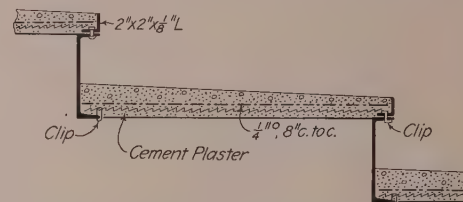
DELIVERY and erection of 1000 tons of steel in the Federal League baseball grandstand in Chicago were accomplished in seventeen days. From start to finish this was a rush job. On account of the length of time required by the building department for the setting of the concrete, the original plans, as noted in the Engineering Record of March 28, page 355, calling for a structure similar to the American League stand, were changed almost over night to a steel structure with thin concrete treads. This change was decided upon Saturday, Feb. 28, at noon, and sufficient details were completed so that the contract was let on Tuesday, March 3, to the Blome-Sinek Company, who sublet the steel work, dividing it between the American Bridge Company and the South Halsted Street Iron Works.

Foundations of concrete were started even before the frontage consents and building permits were obtained on March 6. By March 16 the foundations were in readiness for the steel erectors, the Bergendahl-

Knight Company, who raised the members with two 75-ft. steel traveling booms beginning at the outer ends and closing at the center. Four of the forty-seven roof trusses were placed each day, the remainder of the total period, March 16 to April 2, being taken in unloading steel.

In order to make the delivery required it was necessary to use in the structural plan stock material in the Chicago yards, or such shapes as were on the rolling schedule of the mills during that week. Most of the columns were of 8-in. H sections.

With the exception of the risers there are few novel features. Ten-inch 15-lb. channels, 2 ft. 9 in. back to back, rested on 15-in. I-beams framed into the columns. To do away with carpenters Corr-mesh

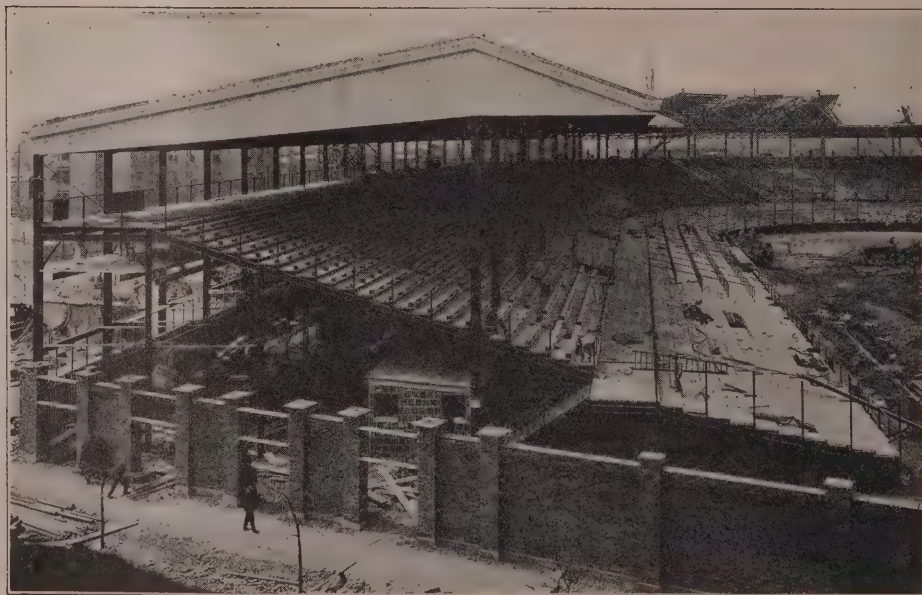


DETAIL OF STEEL AND CONCRETE RISER

reinforcing was laid over the bottom flange of the high channel and on top of the lower one, which had a 2-in. angle set on top of it to form a nosing for the treads. Concrete spread over the reinforcing was screeded by a templet resting on the nosing angle and held up to the flange of the channel. The bottom of the risers was plastered with cement mortar.

Concrete for the treads was mixed in the proportions of 1 part Universal Portland cement to 2 parts sand to 4 parts broken stone. Two portable towers were used to elevate the concrete to the deck at the back of the grandstand, whence it was conveyed by chutes to place. While the concrete yardage was not large it was scattered over a large area, and three mixers, a Cube, a Koehring and a Marsh-Capron, were used.

Zackary T. Davis was architect for the structure and grounds, which were completed in time for the opening game April 23. The Wescott Engineering Company made the changes to steel from concrete in the original plans, which were drawn by E. C. & R. M. Shankland.



VIEW OF FEDERAL LEAGUE GRANDSTAND AT CHICAGO NEARING COMPLETION

Gatun Hydroelectric Development

Power Necessary to Operate and Illuminate the Panama Canal Is Developed at Gatun Spillway by Three 3600 Horsepower Turbines

At the Gatun spillway of the Panama Canal a 7500 kva hydroelectric station has been built in order to furnish the power necessary to operate and illuminate the canal. In addition to this development there is a 4500-kva auxiliary steam station at Miraflores equipped with Curtis turbines. The capacity of the Gatun development can be doubled should the future electrification of the Panama Railroad require this power. The intake, therefore, has been built for six penstocks of which, at the present time, three have been installed.

The gross head available from Lake Gatun to mean tide level of the Pacific Ocean varies from a maximum of 91 ft. to a minimum of 79 ft. The plant, therefore, is designed to develop the maximum effi-

ciency of the turbines when operating under a head of 75 ft. For three or four months of every year there is no rainfall, and during this period it is desirable to conserve the water as much as possible. Water is taken from Lake Gatun through passages, 12 ft. wide, fitted with wrought iron racks 29 ft. 7 in. high to prevent trash from entering the pipe lines. The water is admitted into the pipe lines through three 10-ft. 6-in. diameter head gates. These gates are made of cast iron with seats of bronze.

GATES

Each gate is equipped with two steel stems fitted with bronze nuts working in roller thrust bearings, and the nuts are fitted with steel bevel gears arranged to be operated by a 15-hp., 220-volt, alternating current motor with a speed of 750 r.p.m. The motor is placed between the stems and has shaft-extensions on each side carrying two bevel pinions arranged to engage the gears on the stem nuts. The stands which carry these nuts are equipped with hand operating mechanisms, arranged to be disconnected when the gate is operated electrically.

The gates are equipped with automatic control devices, consisting of a limit switch geared to one of the gate stems and a float switch actuated by the water in the pipe. The action of the control—the gate being closed and the pipe-line empty—is as

follows: The gate motor switch is closed at the power house, starting the motor and opening the gate. When the gate has opened a sufficient distance to fill the pipe line in about 5 min., the limit switch opens the circuit and stops the motor. The gate remains in this position until the pipe line is filled. The water rising in the 36-in. air vent below the gate actuates a float switch and again closes the motor circuit. When the gate is opened the limit switch again operates to prevent over-travel. The gate is closed by reversing the main switch at the power house, causing the motor to operate, the limit switch again stopping it when the gate has reached the closed position. In case the electric power should fail, the gates can be hand-operated by two men.

Each of these gates is bolted to a pipe

floor, and two galleries. The turbine pit, with an area of over 2100 sq. ft., is located 6 ft. below the level of the main floor.

The main floor is divided into two parts, one being partitioned off and devoted to the use of the electrical equipment, and the other forming an uninterrupted passage on the longitudinal axis of the building, terminating with two large entrance doors at either end.

Concrete stairways at either end of the building give access to the mezzanine and second galleries, devoted to the switchboards, oil switch compartments, reactance coils and other electrical equipment. Two such galleries extend the entire length of the station on the northeast side, and in the south corner are superimposed two smaller ones used as a machine shop and an office, respectively.

The three 2000-kw. main generating units in the hydroelectric station are driven by 50-in., vertical, single runner, Francis turbines manufactured by the Pelton Water Wheel Company. Each turbine has a maxi-



DOWNSTREAM VIEW OF THE GATUN DAM, SHOWING THREE PENSTOCKS AND UNITS ERECTED FOR THE DEVELOPMENT OF POWER

line 10 ft. 6 in. in diameter with an average length of 420 ft. The pipe lines are made of $\frac{3}{8}$ -in. steel plates in rings 8 ft. long, each ring being made of three sheets to form the circumference. The center of each ring is fitted with a 3 x $\frac{3}{8}$ -in. Z-bar ring also made in three sections. After the pipe was riveted it was covered with reinforced concrete to prevent rusting.

The pipe lines are led down to the rear of the power house on a uniform slope and connected to the turbines in the power house through 90 deg. bends of 70-ft. radius. Each of the pipe lines is arranged for attaching a Pitot tube testing apparatus while in service.

POWER HOUSE

The principal buildings connected with the actual operation of the canal are the hydroelectric station at Gatun spillway; the gate control house at the spillway; the four substations of the transmission system at Gatun, Miraflores, Cristobal and Balboa; and the three lock control houses. All these structures are designed along simple lines in harmony with the unbroken surfaces of concrete of the adjacent engineering works.

The hydroelectric station is 61 x 137 ft. and has an extreme height of 74 ft. The building is designed on the unit principle to admit of future extension and consists of a single room open to the roof. The interior has four principal elevations: a pit for the three 3600-hp. turbines, a main

capacity of 3600 hp. when operating under a head of 75 ft. at 250 r.p.m. The turbines are so located that the center of the runner is 20 ft. above tail water. The water is discharged through steel lined draft tubes, 71 in. in diameter at the top and of an elliptical section of 9 x 17 ft. at the outlet. The linings are made of $\frac{1}{4}$ -in. steel.

Heavy cast-iron distance rings carry the generators. The weight of the revolving parts of each generator and turbine is carried on a roller thrust bearing mounted on top of the generator. The runner exerts an upward thrust of 20,000 lb., when working at full capacity, thereby relieving the thrust bearing of that amount of load.

Oil for the thrust bearing is supplied by a small pump geared to the turbine shaft, and a tank is provided below the pump to receive the overflow from the bearing. In this way a constant circulation of oil is maintained. As this oil returns to the suction tank, it passes through the lower guide bearing on the main shaft, lubricating it.

The runners are made of special bronze and weigh approximately 7000 lb. each. They are taper bored and held in place on the lower end of the shaft by bronze nuts. The surfaces of the runner vanes are all hand finished to reduce hydraulic losses.

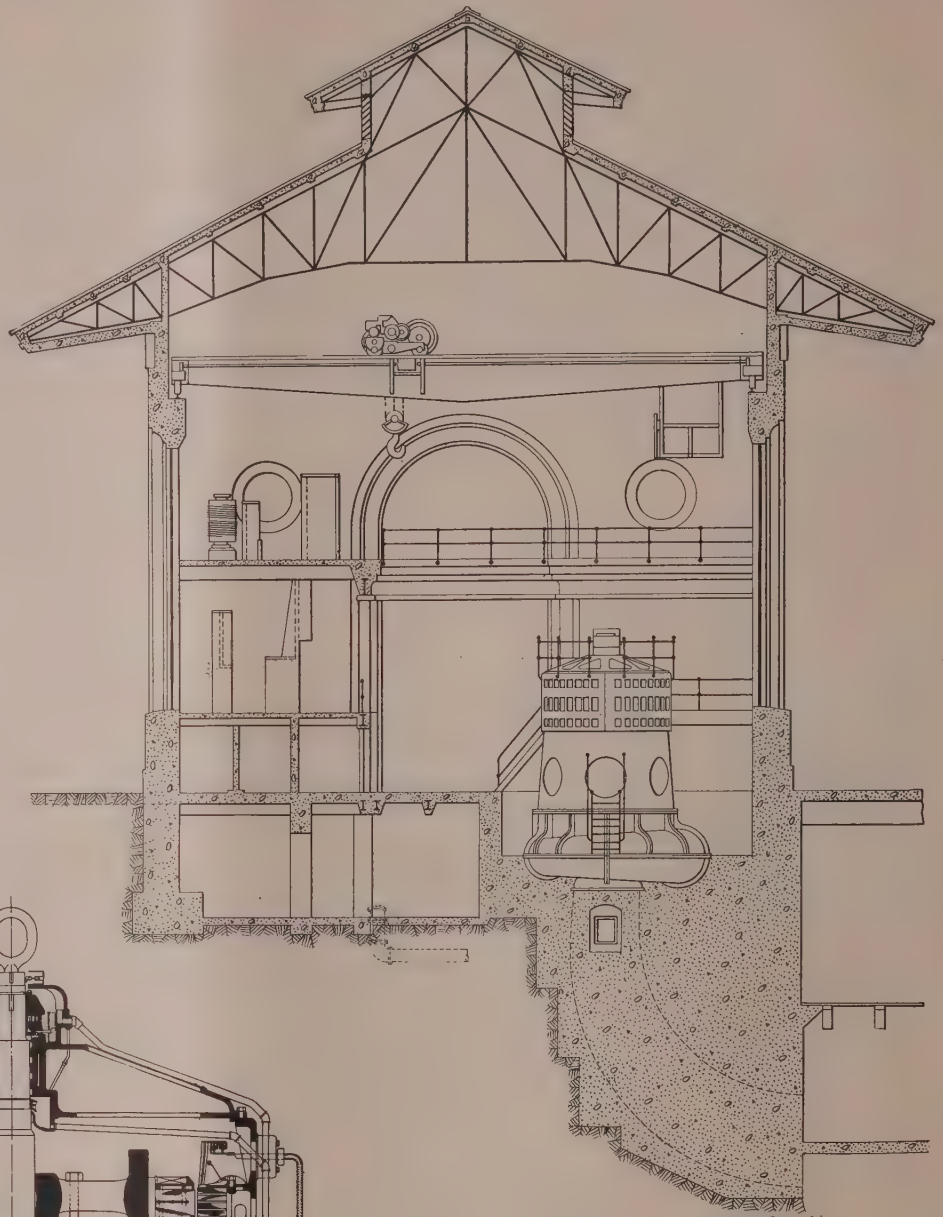
The speed of the turbines is controlled by Pelton oil pressure governors, mounted on the distance rings and driven by bevel gearing from the main shaft.

The governors are fitted with small elec-

tric motors for varying the speed of the main units for synchronizing purposes, and a device is provided on each governor for varying the permanent drop in speed from no load to full load. This can be adjusted for any variation from 5 per cent drop to constant speed from friction load to maximum load. The governors are also fitted with hand control.

Wicket gates for controlling the supply of water to the runner are steel castings with finished surfaces. Each gate has its pivot stem extended upward through a packing gland and is fitted with an operating lever. These levers are connected to the gate ring by bronze links, and the gate ring is connected to the governor rockshaft. All the regulating mechanism is therefore outside the turbine casing, except the gates themselves. The water passages on each side of the gates are provided with renewable rolled steel wearing plates.

Pressure oil for actuating the governors is supplied by two Pelton rotary pumping units, driven by 10-hp. alternating current motors at a speed of 375 r.p.m., each pump being capable of supplying the governors of all three units. The governors work on an open system, no vacuum chambers being used. The discharge oil from the governors is led into sump tanks, from which it passes into the suction of the pumps. Each pump is connected to a steel pressure-oil receiver with an air space above the oil. The sump tanks and pipe connections are installed in duplicate and valves are pro-



CROSS-SECTION OF POWER HOUSE, INDICATING ARRANGEMENT OF MAIN UNIT

vided to enable one set to be cleaned while the other is in service.

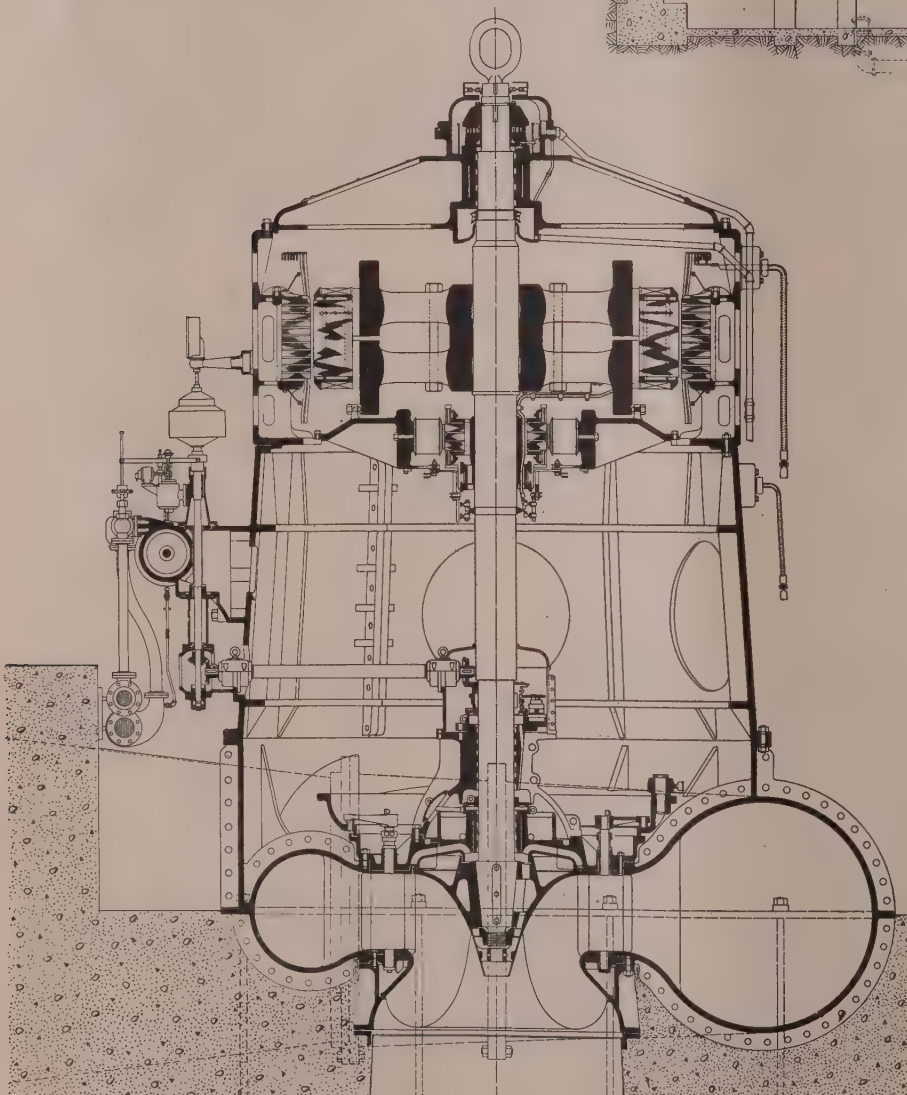
GENERATORS AND EXCITERS

The three main generating units are of the vertical revolving field type, each being provided with a direct connected exciter. The generators are of the General Electric Company manufacture and are three-phase, 25-cycle, with a guaranteed continuous capacity of 2000 kw at 0.8 power-factor, 2200 volts, 250 r.p.m. and with an overload rating of 2500 kw at 0.8 power-factor for two hours.

The exciters which are placed on the turbine shaft below the generator are of 50 kw capacity at 125 volts, each capable of furnishing exciting current for two generators under maximum guaranteed load. Each unit, generator and exciter, weighs approximately 65 tons.

Heavy cast-iron distance rings furnished by the Pelton Water Wheel Company carry the generators, the stationary armatures being bolted to these rings. The thrust and upper guide bearing support consists of a rigid iron casting, bolted to the top of the stationary armature.

The thrust bearings are of the roller type, manufactured by the Standard Roller



SECTIONAL ELEVATION OF UNIT, WITH EXCITER MOUNTED BELOW GENERATOR

Bearing Company, Philadelphia. The suspended weight is 32 tons. The exciter magnet frame is supported by lugs cast on the stationary armature of the main generator. Large holes in the distance ring makes the exciter readily accessible.

Provision is made for securing the magnet frame of the exciter to the revolving element of the generator, so that the complete rotating element, with the exciter frame, is raised at once in disassembling.

For inspection of the roller bearing it is necessary to remove a speed limiting switch from the top of the shaft and the upper

500-r.p.m. generator, direct connected to a 150-hp, 2200-volt, 25-cycle squirrel cage type, induction motor. They are mounted on a common base plate and provided with three bearings. These exciters can also be used for charging the control battery.

DISTRIBUTION

Because of the distance current is transmitted at a voltage of 44,000 from the power stations to both ends of the canal. The step-up transformers are, however, not located in the power plants, but in substations in their vicinities; therefore, the

sories and motors for driving the oil pumps, were designed and built by the General Electric Company. The details of design and manufacture were subject to the approval of the Isthmian Canal Commission's engineers.

The shipping weight of the material furnished by the Pelton Water Wheel Company, including the auxiliary electrical apparatus purchased by it from the General Electric Company, was approximately 1000 tons.

First Indiana Water Rate Decision by Utility Commission

Going Value, Estimated by Consulting Engineers at \$120,000, Is Reduced to \$25,000

A NET return of but 6 per cent on the valuation of the property of the Richmond Water Company was fixed by the Public Utility Commission of Indiana in one of its first water rate decisions rendered June 18. "Going value," estimated at over \$120,000 by Alvord & Burdick and D. W. Mead for the city was cut to \$25,000. Cost of paving laid after the pipes was not allowed. The final value was placed at \$750,000, a sum about 25 per cent less than that fixed by Mr. Alvord and \$48,000 more than the actual cost as shown by the company's books. The commission rescinded the rule requiring a \$10 fee for service connections and would not allow the sum total of these "donations" to be made a part of the capital of the company. By the new ruling the company must lay services to the curb.

"GOING VALUE"

Commenting on going value the commission states that it believes the public has once reimbursed the company for the "lean years" and quotes from a recent case decided by the New York Court of Appeals as to the definition of "Going Value" to the effect that it represents early losses while building up business. Further, according to the commission, the decision makes it clear that where such expenditures and early losses have been reimbursed by years of successful operation of the plant yielding a fair and reasonable return, that the real, unrequited losses and expenditures have been fully paid by the people. Under such circumstances the question of "Going Value" is eliminated.

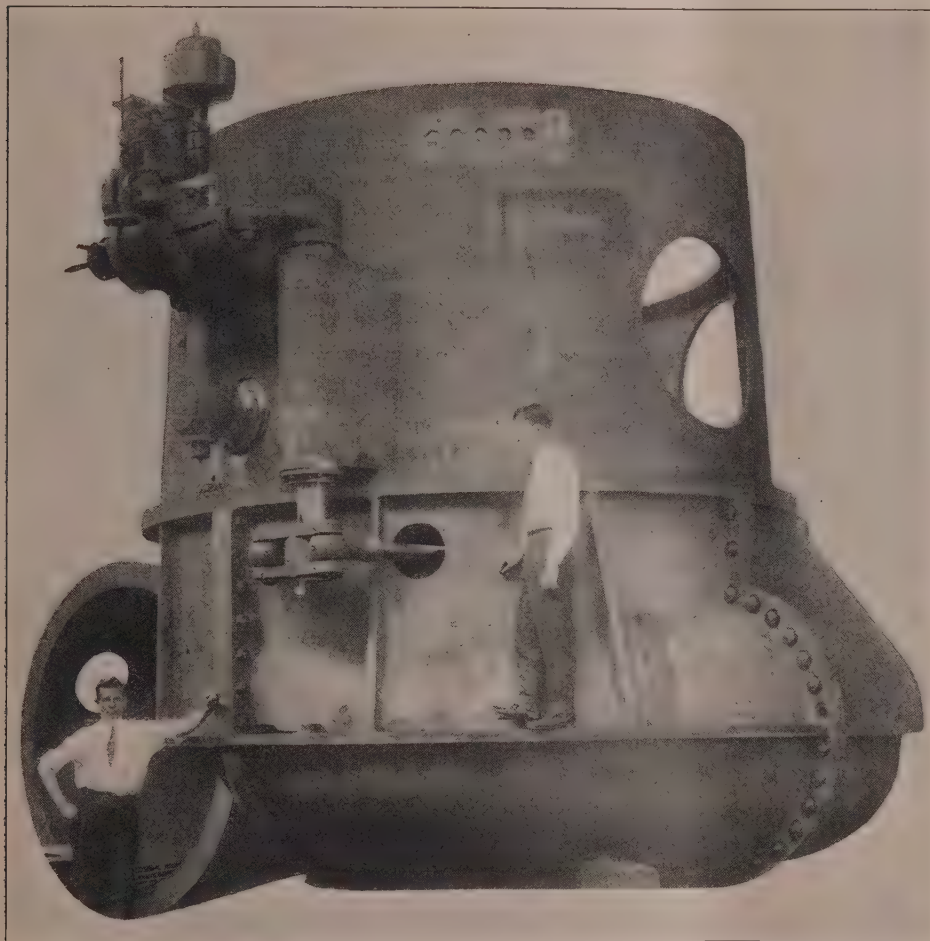
On the fixing of 6 per cent return, the statement is made that about \$300,000 represents an invested surplus over and above reasonable earnings, fixed charges and operating expenses. Otherwise, the investors would be entitled to a higher rate.

Apportionment of the rates between the city and private consumers was done on the basis of the percentage of fire requirements during maximum consumption. By this reasoning the city will pay 32 per cent of the gross revenue which makes the hydrant rental \$55 each per year. In addition the "free water" now furnished the city schools, fountains, and hose houses must be paid for.

Depreciation was fixed at 0.8 per cent and the tax allowance practically doubled, as formerly the company paid \$5761.96 on a valuation of \$215,000.

GRADUATED RATES

Graduated rates for private consumers were set to find the 68 per cent of gross



ASSEMBLED TURBINE, SHOWING GOVERNOR ARRANGEMENT AND LARGE MANHOLES

half of the bearing housing. The arrangement of the unit is shown in the accompanying cross section.

The generators, under official tests, showed an efficiency of 95.1 per cent at 2000 kw, 0.8 power-factor; 94.3 per cent at 1500 kw, 0.8 power-factor, and 92.5 per cent at 1000 kw, 0.8 power-factor. The guaranteed temperature rises of 40 deg. Centigrade above room temperature, of 25 deg. Centigrade under continuous operation at full load and 55 deg. Centigrade rise after two hours' run at 25 per cent overload, were met with an ample margin.

All of the apparatus was subjected to the most rigid and minute inspection during manufacture by representatives of the Isthmian Canal Commission. The insulation of all windings was made moisture proof on account of the extreme climatic conditions on the Isthmus. The revolving field was given a running test at twice normal speed in the testing pit at the factory provided for this special purpose.

In addition to the direct connected exciters, two motor-driven exciters are supplied. These consist of a 100-kw, 125-volt,

power plants generate and distribute only 2200 volt current.

The double 44,000 volt transmission line runs across the Isthmus, connecting Cristobal and Balboa with the two power plants. There are four 44,000/2200 volt substations stepping down at Cristobal and Balboa, and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power. Thirty-six 2200/240 volt transmission stations for power, traction and light at Gatun, Pedro Miguel and Miraflores locks have been provided. Three 2200/220-110 volt transformer stations are installed for the control boards at the locks; and stations at Cristobal and Balboa for the coal handling plants, machine shops and drydocks.

The complete hydraulic equipment for this installation, including the racks, head-gates, pipe lines, Pitot tube testing apparatus, turbines, governors and oil pumping units, was designed and built by the Pelton Water Wheel Company; and all the electrical apparatus, including the generators, switchboards, transformers, head gate motors, limit switches, float switches, acces-

revenues. An annual meter charge of \$2 was fixed with a rate of 20 cents per 1000 gal. for the first 3000 gal. used per month; 15 cents for the next 7000 gal. per month; 12½ cents for the next 80,000 gal. per month; 8 cents for the next 1,000,000 gal., and for all in excess of 2,500,000 gal. per month, 5¼ cents per 1000 gal. Flat rates were not changed from existing schedules. No preferential rates were allowed to the railroads.

Commendation of the plant, its management, and quality of the water is expressed as follows:

"The plant was well constructed and has been prudently managed. There has been no exhibition of frenzied finance. In a plain, business-like way, the company has diligently proceeded to perform the duties it was created to perform. It has furnished

Reinforced Concrete Roof Collapses

Premature Removal of Forms Causes Failure of Upper Story of Large Garage in Ogden, Utah

By RICHARD R. LYMAN

Professor of Civil Engineering, University of Utah

WITHOUT warning the reinforced concrete roof of the two-story garage, belonging to Mrs. David Eccles of Ogden, Utah, collapsed, killing two and seriously injuring four other men who were at work stripping the forms from the concrete. The material in the roof was put in place May 29. The accident occurred June 8, ten days later.

In front of the building proper is a wash rack, covered with a reinforced concrete roof 43 ft. 10 in. long and 22 ft. 6 in.

It is interesting to note that the fallen brick work was caught by the 3-in. roof over the wash rack, without doing any apparent damage to this slab. There has developed an ugly looking crack near the end of one of the 12 x 12-in. beams. It is not, however, the end of the beam that received the load of brick and mortar when the wall collapsed. The crack begins about 18 in. from the end of the beam and extends downward and toward the center of the beam, ending at a distance of about 2½ ft. from its end.

While it is the general practice in this section of the country to strip forms as early as ten days after the concrete has been deposited, when it has no heavy loads to carry, posts which carry important beams are kept in place from thirty to sixty, and oftentimes as long as ninety



FIG. 1—COLLAPSED ROOF, WITH WASH RACK ROOF BELOW



FIG. 2—FALLEN ROOF WITH REMAINS OF EAST WALL

the city of Richmond and its inhabitants an abundant supply of pure and wholesome water. Pressure for fire purposes has been sufficient at all times. There is no complaint of the character of the water now furnished.

"The rate charged has been such as to bring continuously increasing revenues to the company. Salaries charged by the officials have been just and reasonable. There has been no contention that the officials have looted the treasury of the company.

"The city of Richmond is a wealthy, substantial community and has a steady growth in population. With additions and betterments now under construction, the Richmond waterworks will be a very valuable and efficient property. It will be well-equipped to do its work and will have a perfect monopoly for the sale of its service to more than 25,000 people. It has no fear of a rival and a less hazardous investment can scarcely be imagined."

A CAR-DUMPING DEVICE used for box cars at the Strawberry irrigation tunnel in Utah consisted essentially of a traveling stiff-leg derrick with a bail attached to the lower block of the hoisting tackle. The bail engaged a trunnion at each end of the car which was placed above the center of gravity of the empty car and below that of the loaded car. It was locked by a spring latch controlled by a rope operated by the attendant to dump the car which automatically revolved back to upright position as soon as it was empty.

wide. This roof, constructed in the same way as that which collapsed, is supported, as was the other one, by two 12-in. reinforced concrete beams, making the area of the unsupported slab of the former 14 ft. 2 in. by 21 ft. and of the latter 14 ft. 2 in. by 25 ft. 2 in.

According to the specifications, these roofs were to be of reinforced concrete, 3 in. thick. Rods, ¾ in. in diameter, were to be placed 12 in. on centers "the short way" and 9 in. center to center "the long way." The specifications also call for heavy hog wire to be placed 1 in. above the reinforcing rods. Continuing the specifications read: "This slab shall be supported on the brick wall all around and on the two 12-in. concrete beams through the center, which beams shall be reinforced with five ¾-in. round rods, bent to detail, and sixteen shear loops made of ½ x 1-in. strap iron, bent to detail and spaced as directed. All shall be thoroughly wired in place." The sixteen shear loops were not placed in the beams, and the hog wire was not placed in the slab. While there is no detail in the plans showing where the five round rods were to be located in the 12 x 12-in. beams, the location of the reinforcement in the larger beam gave an idea of the intended location of the reinforcing rods in the smaller beam.

In the left-hand portion of photograph is shown the 3-in. slab which makes the roof over the wash rack. The 12 x 12-in. beams supporting this slab cannot be seen in the picture.

The posts supporting the beams under the roof which collapsed, it is understood, were being removed at the time of the accident, which, as stated above, was but ten days after the concrete had been put in the forms.

The men removing the forms were employed by the Dinwiddie Construction Company, of which William A. Larkin is vice-president and manager. This construction company has recently completed the Kiesel Building, reinforced concrete construction, at a cost of \$150,000, and also the Eccles Building, steel frame work construction, costing \$325,000. The men who were removing these forms had been employed on both these buildings and, therefore, were experienced in this class of work.

The reason given for the early removal of these forms is that the men had been out of employment almost continuously for two weeks, because of rain. They began doing outside work Monday, June 8. When it began raining, in order to be employed, they began the removal of these forms. Eber F. Piers, of Ogden, is the architect for this building.

DELAY of the proposed North River bridge and tunnel improvement for New York City is involved by the refusal of three of the five New Jersey counties interested to participate in the construction. The remaining two counties cannot alone fulfill the requirements of the law and the failure of a third county to participate makes the present legislation inoperative.

Paris Streets Undermined by Flood from Broken Sewers

Storm Water Enters New Subway Excavation and Causes Extensive Caving

CHOKED to capacity with water from a violent storm on June 15, many sections of the sewerage system of Paris, France, uncovered by excavations for the city's new subways, broke, flooded the underground workings, and caused extensive caving of the streets. A member of the staff of "Engineering," London, inspected the damage done and from his report, published in the June 19 issue, the following abstract has been taken:

The driving of the new underground line appears to have been the immediate cause of the catastrophe. The existing masonry sewers seem to have been shored

erally driven at the central and top portion of the full tunnel section, side excavation being then carried out, the excavation being timbered fanwise to the right and left-hand sides of the heading.

The centers on which the masonry arch is to be built are then laid. The arch, therefore, is supported by the surrounding ground for a more or less lengthy period; excavation is then continued in the central part of the full tunnel section, sufficient earth being left under the springing of the arch on each side to support it until the masonry sides of the tunnel are built in.

It is impossible so far, according to "Engineering," to state the causes which have led to the accidents in question, but it is permissible to suppose that the water which rushed into the tunnels in course of construction, owing, no doubt, to the rupture of neighboring sewers, undermined the

alone, supported above the edges of the hole, forming a kind of thin crust. At this part an automobile was partly engulfed, and the two passengers who perished in the accident were more likely drowned than killed by the accumulation of debris. The carrying away of the earth by the water is also illustrated by the fact that at many points of the roadways under which the new line runs the paving has become most uneven.

The sewers were strongly built in the first instance; this is fully recognized; but it is quite evident that when they have accidentally to withstand enormous internal pressures at a time when they are temporarily uncovered or undermined due to neighboring excavations for other purposes, they may fail, as they have done in the instance under consideration. The occurrence affords a confirmation of the



SUBSIDENCE IN RUE DE LA BOËTIE



HOLE IN THE PLACE ST. AUGUSTIN

up over the tunnel driven to take the line; they appear to have broken down at parts, and the water, by flowing into the tunnel, led to undermining and to the caving-in of the tunnel arch by carrying away the earth and stone on which the arch rested temporarily, and also by carrying away at intervals the masonry walls which formed its final support.

It is quite evident that the excavation work, which the construction of all the subway lines involves, is surrounded with most serious difficulties, carried out as it is in the very soft earth which constitutes the subsoil of Paris, amongst a most complicated network of sewers and pipes, and very frequently through bodies of underground water.

PARIS SUBSOIL

The Paris subsoil is of a most heterogeneous formation, being often made ground, cut about by the ruins of old constructions. It has been practically impossible all through to make use of the tunnelling shield. Therefore the contractors are compelled to have recourse to tunnel excavation with timbering. For the newer lines in course of construction fears were entertained in regard to the cut-and-cover method, since this would have meant the opening up of the streets and avenues, and would have prevented for some lengthy period the circulation of vehicles at the parts where the work was being carried out. At intervals, therefore, shafts are sunk from which the galleries are driven; an advance heading of small section is gen-

erally driven at the central and top portion of the full tunnel section, side excavation being then carried out, the excavation being timbered fanwise to the right and left-hand sides of the heading.

SETTLEMENT OF SEWER

It would seem logical to suppose that the main sewer, owing to the enormous mass of water it had to deal with a few minutes before the accident, was not adequately supported by the surrounding earth, which had been distributed by the previous excavations. Settlement took place, causing the sewer to crack, the water penetrated the tunnel workings, causing undermining to commence, the complete breaking down of the main sewer followed, leading to the undermining of the tunnel and to the caving-in of the streets.

A most violent storm occurred in Paris on Monday evening, June 15, the result of which was no doubt completely to flood the main sewers in an instant. In cases of this kind, the sewers can be made to discharge into the river, but the flood took place with such rapidity that no time was available for recourse to this means, and the sewers settled in places into the subsoil already weakened by the extensive excavation works in progress for completing the Metropolitan subway line system. In a few instances a veritable torrent was carried through workings that were not able to resist it, and, in truth, not built to give passage to it. One of the holes does not afford direct evidence of the fracture of the main sewer, but it does show the marks of the passage of a mass of water which has washed away the earth-work up to the level of the wood paving. This latter remains

absolute necessity for all municipal engineers to make the most complete provision for coping adequately with periodic floodings caused by storms. It should also afford a confirmation of the fact that the use of the tunneling shield and the construction of tunnels by complete metallic rings afford a much larger margin of safety than the methods followed in Paris. But the statements of the majority of the Paris contractors agree in showing that in the French metropolis the use of a tunneling shield is attended with many difficulties, not to say practical impossibilities.

A REVOLVING HANGAR for the dirigible balloon "City of Luzerne," which makes excursions over the Lake of the Four Cantons, Switzerland, has been built to enable the shelter to be moved so as to allow the entrance and exit of the balloon from any point of the compass, depending on the direction of the wind. The hangar, 428 ft. long, 100 ft. high and 85 ft. in clear width inside, has a steel framework with trussed arch-like transverse bents about 30 ft. apart, supporting the continuous roof and wall surfaces. These bents are seated on full-length trussed longitudinal stringers; the latter are braced in the horizontal plane to form a truss resisting transverse forces, and are supported on a central turntable 131 ft. in diameter, while the overhanging ends are supported on an auxiliary concentric roller track 312 ft. in diameter, beyond which both ends of the hangar cantilever from one to three panels.

Book Reviews

"The Cement Industry in the United States in 1913" is the title of a 27-page bulletin issued by the U. S. Geological Survey and written by Ernest F. Burchard. The bulletin has tables showing the fluctuations in the value and output of Portland, natural, puzzuolana and slag cements and the export and import of cement. The bulletin shows that the output of cement is steadily increasing. (Washington, D. C., U. S. Geological Survey.)

"Investigations on Drain Tile" is the title of a 112-page report of Committee C-6 of the American Society for Testing Materials recently issued as Bulletin 36 by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts. The bulletin is divided into seven parts as follows: "Part I, History and General Explanation, Committee C-6 and its Work"; "Part II, Special Tests of Clay and Concrete Tile for Committee C-6 at Ames and Jefferson, Iowa," showing comparative results with three different bearings; "Part III, Data on the Manufacture of Concrete Test Tile for Committee C-6 at Jefferson, Iowa"; "Part IV, Miscellaneous Additional Comparative Tests of Clay and Concrete Drain Tile and Sewer Pipe by Sand Bearings and by Three-Point Bearings"; "Part V, Data on the Calculation of the Modulus of Rupture of the Material in the Tile Shells from the Results of Strength Tests of Drain Tile"; "Part VI, Data on Calculation of Supporting Strengths of Drain Tile in Ditches and Loads Thereon and the Selection of Proper Factors of Safety for Different Ditch Laying Conditions"; "Part VII, Summary and Conclusions from Investigations of Committee C-6." (Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.)

The Metropolitan Sewerage Commission of New York has issued its final report, embodying the results of its examinations of the pollution of New York harbor and the rivers tributary to it and recommendations for the collection and treatment of the city's sewage. The report is voluminous—762 pages—and is replete with maps and charts. In addition to the studies conducted by the engineering staff of the commission the book contains a number of reports of experts called into consultation to render opinions on special phases of the subject. Part 1 summarizes the work done from 1906 to 1914. Part 2 describes the plans for main drainage and sewage disposal works which the commission recommends the City of New York to construct for the protection of the harbor. Part 3 contains reports of experts consulted by the commission, including five critical reports and four reports upon special topics, together with digests of these reports and explanatory matter relating thereto. Part 4 contains data relating to the protection of the harbor, including analytical results not previously published, corrected statements with respect to tidal flow, a discussion of the present status of sewage disposal and practical examples of main drainage and sewage disposal works of various large cities. The report is signed by George A. Soper, chairman of the commission, James H. Fuertes, H. de B. Parsons, Charles SooySmith, and Linsly R. Williams.

LUMBER AND ITS USES. By R. S. Kellogg. Cloth, 6 x 8½ in.; 352 pages; illustrations and tables. Chicago, The Radford Architectural Company. \$1.

This is a book of general information for those who are not well versed in the subject, compiled from various sources. Beginning with the structure and physical properties of wood, the author proceeds to lumber grades, standard sizes of lumber (set forth with drawings and tabulated dimensions) and shipping weights. Sixteen pages on structural timbers, in which are given standard definitions and Forest Service rules, are followed by chapters on seasoning of timber, wood preservation, paints and stains, wood paving blocks, hardwood flooring and fire resistance. Then follow a few pages on lumber prices, after which under the two headings "The Uses of Lumber" and "Commercial Woods" the author gives 150 pages to a presentation in rather painful detail of the uses, in percentages, to which each kind of lumber is put, and the kinds of wood, also in percentages, which supply the material for practically every wooden commodity. After this are statistics as to forest products and the timber supply, and not the least valuable part of the book is a nine-page section giving sources of information about lumber.

Covering such a broad subject, the author necessarily only scratches the surface of some of his headings. The book is set in large type and is easy to read. The illustrations of forests, lumber plants and lumber products brighten the prosaic nature of much of the statistical matter. The drawings are rather crude, especially those showing standard sizes of lumber, where the dimensions are crowded on in bewildering fashion. While there is an index and list of plates at the end of the book, there is no table of contents, the chapters are not numbered, and the reader can tell only by going through the book what is presented and how much space is given to the different heads.

COMMERCIAL CALCULATOR. By Edward L. Cox. Cloth, 7 x 10½ in.; 101 pages. New York, Funk & Wagnalls Company. \$10.

This book is designed to simplify multiplication and will be especially valuable as a clerical aid in large business establishments. It consists of a compilation of tables, the use of which in finding a product involves only subtraction or addition and the visual checking of the tables. The direct use of the tables applies to multiplying two numbers whose sum is not more than 202,000, but extension to include factors not coming within this limit is not difficult. The system is readily adapted to an adding machine. The use of red and black type of various sizes and degrees of sharpness aids the eye in using the tables.

ROCK EXCAVATING AND BLASTING. By J. J. Cosgrove. Cloth, 5½ x 8½ in.; 181 pages; 72 illustrations; 13 tables. Pittsburgh, National Fire Proofing Company. \$2.50 net.

The book is intended to show a "person wholly unfamiliar with blasting and explosives how to intelligently superintend rock excavating or do it himself." Text and illustrations show how to drill bore holes to get different results, how to charge them, how to drive a tunnel, how to sink a shaft, and also deal with blasting in quarry work and open-cut excavating, care, handling and storage of explosives, and the tools and machines required in rock excavating. Separate chapters are devoted to the force

and direction of a blast, sinking shafts through rock, tunnel driving, and different types of commercial machines and explosives and their operation. The book is a reprint of serial articles published in "Building Progress."

AUTOMATIC SPRINKLER PROTECTION. By Gordon Dana, S. B., Manager of the Underwriters' Bureau of New England, Boston. Cloth, 5½ x 8½ in.; 407 pages. Boston, Thomas Groom & Co., Inc. \$3.

This book is based on lectures delivered before the Insurance Library Association of Boston, in 1913, covering the third-year course in the subject of fire protection as outlined by the Insurance Institute of America. The lecture notes have been greatly amplified and an appendix has been added illustrating and describing all sprinkler heads for which information could be obtained, with a view of providing a textbook for persons studying sprinkler protection, and a reference book for those versed in it. Several systems of perforated pipes are illustrated and described, and separate chapters are devoted to tests and characteristics of sprinklers, to installation rules governing location, circulation, connections, hose, spacing and pipe sizes, layout of equipment, feed mains, fittings, test pipes, pressure gages, protection against freezing, water supply, gravity and pressure tanks, pumps, alarm valves, dry valves and sprinkler supervisory systems. The book contains valuable information conveniently arranged and includes directions, explanations and descriptions that will be of service to architects, owners and superintendents in selecting, installing and maintaining different systems of fire protection.

CAMBRIA STEEL. By George E. Thackray, Special Engineer, Cambria Steel Company. Flexible leather, 4½ x 6¾ in.; 513 pages. Cambria Steel Company, Johnstown, Pa. \$1.25.

This eleventh edition of the rolling-mill handbook contains a large amount of general information concerning dimensions and properties of structural steel, special shapes and bridge members, and the usual tables of mathematical tension and standard materials. It embraces a large list of steel manufactured by the company, including structural steel, cars, rails, axles, crank pins and piston rods, bolts and rivets, forgings, merchant bars, agricultural shapes, plow steel, disks, wire, wire rods and wire products and cold-rolled, cold-drawn and pressed steel. The list has been revised to correspond with discontinuation of old shapes and additions of new ones. There are new tables for 24-in. I-beams, additional tables of weights, dimensions, properties and safe loads, tables of the properties of standard rails, including those of the new standard American rails, and amplified tables of plate girders and flat-rolled steel bars.

The tables of timber data are considerably amplified and the 1914 specifications for structural and boiler steel are given. A notable feature is the enlarged space given to building codes. This includes a digest and tabulation of the building laws of thirty-one cities, covering twenty-two pages, with floor loads for seven different classes of building, unit stresses in tension, bending, compression, and shear for rolled and cast steel and iron, column formulae and allowable unit stresses for masonry and for the bearing capacity of soils, safe loads on wooden piles, compression, fiber, tension, and shear stresses for seven principal kinds of timber, and unit stresses for timber columns and for reinforced concrete.

Letters to the Editor

Compensation of Engineers

SIR: So much discussion has followed the publication of the American Society of Civil Engineers' special committee report on the compensation of engineers, and so much adverse criticism has been made to the effect that the average compensations reported are not indicative of the actual conditions among engineers, that I have gone back over my ten years of income records to compare my actual earnings with those reported to the American Society committee. In nearly every discussion on the subject generalities only have been touched upon; I have seen none in which specific cases were given. Of course one specific case does not mean much, but mine, because I believe myself to be very near the average and my experience has been very nearly the same as the experience of my engineering acquaintances, is very probably close to that of the middle man. By middle man I mean the one who has an equal number above and below him.

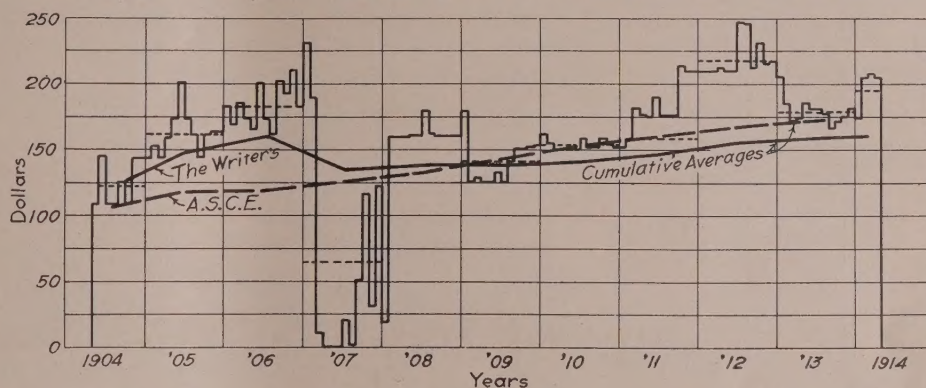
Being of a statistical turn of mind, I have kept all sorts of personal records pertaining to income, expenditure and various other items. A diagram has been prepared showing my monthly income for the first ten years of my experience, which ended April 30 this year. Averages for each year have also been shown thereon, as well as accumulated averages. The line, which I have called cumulative average, shows the monthly average for the entire period from the beginning of the ten-year period up to the point at which the curve is read. Plotted thereon is also a cumulative average based upon the averages taken from the committee report with the highest salary in each year eliminated. These extremely high salaries are eliminated because they undoubtedly represent other than engineering ability.

It will be seen by examination of the diagram that my cumulative average and that of the committee cross in the fifth year, mine being considerably higher during the earlier period and slightly lower during the latter. This is due, no doubt, to the very lean year during 1907, when I was hobbling around on crutches—a condition which would be eliminated by averaging a number of men. By assuming that the year 1907 would have averaged with 1906 and 1908, which would have been the case with normal conditions, my average and the committee's would be almost identical. In fact the accumulated earnings for the ten-year period, in my case, would have been \$20,267, and that of the committee \$20,679—a difference of but \$411 in ten years. The actual difference, however, is \$1,637. All of which goes to show that my statement that I am an "average" engineer is a true one. It is not believed, however, that the committee's report represents true conditions throughout the profession at large, but among the society's membership only.

Being one of those fortunate individuals who believes that other things count in life as well as money, I also find in my records that I have accomplished 89,695 miles of travel, of which 19,946 miles were by water, and approximately 2500 miles by horseback. This travel was in the States of Illinois, Iowa, Missouri, Kansas, Colorado, Wyoming, Nebraska, Utah, Nevada, California, Arizona, New Mexico, Texas, Oklahoma and Louisiana, the Territory of Hawaii, the in-

sular possessions of Guam and the Philippines and in Mexico, Japan, China and the colonies of Hong Kong and Macao. To appraise the money value of this fairly extensive travel and the opportunities for sight-seeing and study would be a difficult matter, but it might be fair to assume that it would be at least worth the cost of making the trips plus the loss of time and salary involved. All of which would be several thousand dollars. I, however, value the experience even more highly.

I also find that I have had charge of about \$625,000 worth of construction work, a large amount of design not definitely translated into dollars, and have handled labor of the following nationalities: Americans, Europeans, negroes, Apache and Navajo Indians, Sikhs, Japanese, Chinese, Mexicans, Tagalogs and Visayans, which list in-



CUMULATIVE AVERAGE OF THE WRITER AND THAT OF THE AMERICAN SOCIETY

cludes the white, yellow, red, brown and black races and many of the mixtures.

As offsetting all these things, my retrospect shows seventy-seven days in a hospital bed, one hundred and seventy-one days on crutches, one broken bone and one crushed knee.

In summing up, the question arises, "Does engineering pay?" This will be answered differently by men holding different viewpoints. From a standpoint of money alone, perhaps not. From the standpoint of money plus travel and its attendant education and broadening influence, perhaps so. It all depends upon the viewpoint. The principal drawback to engineering, as I see it, is its enforced roving. This roving is all right in a man's earlier years, and is a part of the character, almost an instinct, of the engineer. But man is primarily a home builder, and there comes a time in even an engineer's life when he wants to settle somewhere and establish a home. The very nature of engineering work, however, precludes this, except in the case of a limited number.

This feature of engineering is one which every student of engineering should consider, as having a very important bearing upon his future life. I have had but three positions in ten years, but the longest period spent in one place is two years and eight months, the other "stops" being for 4, 5, 10, 11, 12, 14, 16 and 16 months respectively. Is it any wonder that after ten years of it, a desire to stay "put" comes to the fore?

Another drawback closely related to the above is the lost time coincident with reduction of forces, the close of a job, etc., which plays such a large part in the life of most engineers. I have been extremely

fortunate in this respect, however, as I have never been out of a position except by resignation. It has been variously estimated that the percentage of lost time in engineering is from 25 to 33 1/3 per cent. However close these estimates may be, the loss of time is a factor to be seriously considered, as it militates against the planning for the future in the way of investments, etc., to say nothing of the suspense in which an engineer always lives, and the expense incident to moving about from place to place.

Most of us, however, would not care to be in any other profession, even though the other professions might pay better. For where can one find the satisfaction in doing things, of accomplishing something, of producing, that can be found in engineering and its allied fields? And that is what the majority of engineers want, the satisfaction of work well done. Do we not all like to see

the finish of anything we start, regardless of money? How many of us would give up an important piece of work nearing its completion for an offer of a larger salary? Not many, I believe. The successful completion of a large and important piece of work is to most engineers what a babe is to its mother. The satisfaction of seeing it grow and approach completion is worth a great deal.

After all is said and done, and the past ten years reviewed, the question "Does engineering pay?" remains unanswered.

A TEN-YEAR-OLD.

Failure of Temporary Flume Used in Making Fill

SIR: A structural-steel company is building a new plant on the west shore of the Willamette River in Portland, Ore. The plant is located on a plot of ground about 300 x 1000 ft., which has been leased for a period of years. It has a frontage of about 320 ft. on the river, which passes at an angle. Most of the site is slightly more than 12 ft. above low-water line, although a small portion reaches El. 18. It has to be filled to El. 28 over the yard and under the shops. Considerable of the fill has already been made and the buildings are near completion.

It was planned to make the fill with a hydraulic dredge, but none could be engaged at the time. A contracting firm that has been making fills along the waterfront for several years was therefore employed. Its method is to bring in barges the material, which is mostly gravel dredged from various points in the river, to the steel company's dock at the front of the property,

hoist it into a hopper built on a wooden tower on the dock, pump water into this and sluice it to different parts of the site.

The top of the hopper is about 40 ft. above the dock. The flume is made of wood in sections 16 ft. long, about 2 ft. wide and 1 ft. deep in the clear. As originally intended, the flume was set up with bents 48 ft. apart, the sections being trussed together in groups of three. The drawing shows the details of design.

Work was started with the flume set up in this manner. Soon after beginning, or on Dec. 29, 1913, the flume choked up between the hopper and first bent, due, it is stated, to a stump getting into the hopper and to the workmen shoveling the material into the nearer end of the flume. While a workman was clearing it out the span collapsed, the end adjoining the first bent turning over endwise upon the middle piece. The man was thrown to one side

done; 3 x 8-in. girts were placed at mid-height, and where the direction of the flume changes four post bents were used. No further trouble has occurred.

HENRY BLOOD,
Portland, Ore. Bureau of Buildings.

Design of Reinforced-Concrete Retaining Walls

SIR: In your issue of May 2, page 516, is a letter by Edgar K. Ruth in which he takes exception to the method used by myself in a letter appearing in your issue of Jan. 17, page 86, concerning the design of reinforced-concrete retaining walls. First: Mr. Ruth states that "careful study of the design presented has failed to show me where the author has considered or provided for the direct compression produced in the concrete and steel, at the section of

assumed at such a height that the thickness figured to develop both the steel and the concrete to their fullest for the moment would be so small as to preclude using it, say 4 to 6 in., no engineer in this country would even contemplate a face wall for a retaining wall of such thickness. Therefore he would establish the thickness and then figure the necessary reinforcement, which cannot be done by the method set forth by Mr. Ruth.

In this method set forth by Mr. Ruth he has made the same mistake which he claimed I had made of ignoring the dead weight of the wall section, as is shown in the equation immediately following equation (5) of his letter in which he says

$$A_s f_s = f_c b x / 2$$

which shows him equating the total tension to the total compression, which is correct only when moment alone exists on a section, with no direct stress. The results obtained by Mr. Ruth from his formulae can also be obtained much easier by the ordinary formulae of flexure without direct stress, it being unnecessary to solve any such complicated equations as he proposes.

As I stated in my letter of Jan. 17, the rigid solution of the problem of combined bending and direct stress with reinforcement in one face only is very laborious, involving the solution of a cubic equation to determine the depth to the neutral axis, and my cut-and-try method is much simpler when the thickness of the wall is assumed first, as is often, and I might say usually, the case. Even to solve by the use of formulae it is necessary to assume the area of reinforcement and thickness of section and then calculate the unit stresses, and if these are not all right to try again with new assumed values.

DONALD N. BECKER,
Bridge Designing Engineer, Division of
Bridges and Harbor, City of Chicago.
Chicago.

Effect of Gasoline Fires on Reinforced Concrete

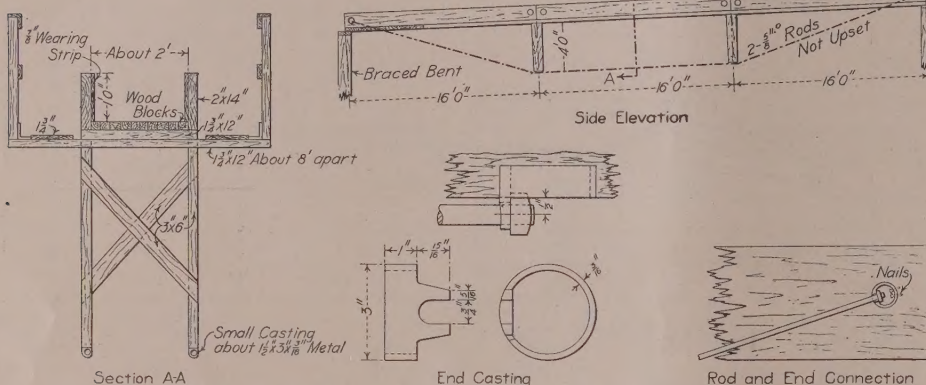
SIR: We are interested in the construction of a reinforced-concrete building for a chemical company, to be used in storing gasoline, and are very anxious to get any information possible in regard to the effect of an intense gasoline fire on reinforced concrete. We would appreciate it if you could refer us to any record which you may have in regard to fires in buildings of this character.

GAMBLE CONSTRUCTION COMPANY.

St. Louis.

[Possibly readers of the Engineering Record may be able to tell of the behavior of reinforced concrete under such conditions.—EDITOR.]

MANGANESE RAIL on sharp curvature and under heavy traffic has shown little wear at the approaches to the Chicago terminal of the Chicago & North Western Railway. W. J. Towne, assistant general manager, writes that close inspection recently made shows that the high rail appears to be wearing slightly, but that the action is so slight that it is scarcely noticeable. He states that there is no flowing of metal on either the high or the low rail, but that there are a number of rough spots developed on top of some of the rails, due to locomotives sliding.



DETAILS OF FLUME THAT COLLAPSED, SHOWING FLIMSY CONSTRUCTION

and severely, but not fatally, injured. An examination of the wrecked portion two hours afterward indicated that one or more of the end castings had pulled from their sockets. The pieces had been somewhat disturbed, and it was necessary to obtain information from the foreman on the dock. Absence of effective counterbracing in the center panel may have contributed to or caused the failure. There were 1 x 6-in. pieces, not shown in the sketch, nailed to the struts and side of the trough, that would act slightly as counterbracing.

A few figures show that the construction was deficient. The weight per linear foot of flume was 65 lb. The weight per linear foot of 2 cu. ft. of water mixed with gravel would be at least 125 lb., probably more, making the total load 190 lb. per linear foot. The stress in each rod was 5700 lb., or 28,000 lb. per square inch of cross-section at the root of the threads. The bearing of the casting against the wood was 1880 lb. per square inch, and the movement tending to twist it out of its socket at least 1 in. by 5700 or 5700 in.-lb., and probably more. The lifting force at the outer edge would thus be 5700/3, or 1900 lb. A couple of small nails driven into the plank and clinched over the top formed the only provision to resist this. The stress in the lugs holding the ends of the rods approaches the ultimate strength of the metal, unless the bearing came on the inner edge of nut. Other parts of the construction appeared very weak, but did not show any signs of failure.

After the collapse the contractor seemed anxious to make the structure safe. Well-braced bents were placed under the ends of every section and the trussing was aban-

doned, by its own dead weight." Apparently he altogether missed equation (3) of my article, which is one of the equations of condition imposed and which says that the algebraic sum of the total tension and the total compression shall equal the thrust on the section, which latter can refer to no other force than the dead weight above the section.

A little further on in my article he probably overlooked the paragraph stating "The weight of the wall above the section assuming concrete at 150 lb. per cubic foot = 6000 lb." and that this selfsame 6000 lb. was used in determining T (the total tension on the tension side). In my final approximation he perhaps failed to notice that the total tension was not as great as the total compression on the cross-section by this same 6000 lb. Therefore, I contend that having provided for the very force which Mr. Ruth claims I had not, my solution is correct.

However, as Mr. Ruth noted, I assumed a case where the center of gravity of the dead weight fell behind the center of the base, thereby reducing the overturning moment. I did this merely to show a possible saving in a case often occurring. If the center of gravity falls in front of the center of the base, as sometimes occurs, its moment about this center should be added to the overturning moment.

Mr. Ruth next criticised a cut-and-try method as rather roundabout. I claim it is much simpler than applying the rigorous formulae to solve. Furthermore, a cross-section of a retaining wall is often determined by other conditions than the economical thickness of concrete to provide for moment. For example, if a section were

Placing Concrete at 43.5 Cents per Yard

Depositing Masonry in Difficult and Crowded Places in a Tunnel for Less Than One-fifth of the Estimated Cost

CONCRETE is being mixed and placed at a cost of 43.5 cents per cubic yard in the new tunnel for condenser water at the Interborough Rapid Transit Company's power station at Seventy-fourth Street and the East River, New York City. This is being accomplished by the pneumatic method of mixing and placing. The tunnel is 12.5 ft. wide and 12.5 ft. high, and its cross-section is shown in the accompanying drawing. Paralleling this tunnel is an old one, which in the future will be used for carrying the condenser discharge back to the river, while the new tunnel located on the upstream side and 20 ft. distant from the old will be used for the intake of water. The accompanying plan shows the location of these tun-

1:2½:5. From the hopper a 12-in. spiral riveted pipe conveys the materials to the mixer. Water is measured in a barrel, about 0.6 cu. ft. being used per batch. The water is conveyed to the mixer by a 2-in. pipe.

There are three air pipes used for operating the machine, a somewhat different arrangement from that previously described in the Engineering Record. The upper pipe is ½ in. in diameter, is forked and used for operating the gate in the top of the mixer. The next pipe is 1½ in. in diameter, and is used for feeding the aggregates to the conveying pipe. The lowest pipe is 2 in. in diameter and is connected to the elbow below the mixer. The conveying pipe is 8 in. in diameter and is made of English seamless steam tubing. The maximum distance the concrete has been conveyed on the job is 350 ft. horizontally and then elevated 12.5 ft.

Both for the side walls and the arch the rate of progress in placing concrete has

Pneumatic Concreting, Stockton Street Tunnel

Compressed-Air System Transports Concrete as Much as 900 Feet and Places 190 Cubic Yards Per Eight-Hour Day

A PNEUMATIC concrete-placing machine is being used in the Stockton Street tunnel project at San Francisco, described in the Engineering Record of June 27, page 728. The mixing plant is located in the open cut near the south portal of the tunnel. Sand and stone are supplied by gravity from the material bins. The concrete materials are hauled by motor trucks, which dump over grizzlies directly into the material bins.

The concrete placing machine is located about 8 ft. from the mixer, and each batch of freshly mixed concrete is dumped from the mixer into a steel trough leading to the opening in the top of the drum. An 8-in. discharge pipe leads from the bottom of the pneumatic drum through the tunnel to the section being concreted. The air-compressor plant is situated on Pine and Stockton Streets about midway between the two portals. The compressor has a capacity of 1250 cu. ft. of free air per minute raised to a pressure of 115 lb., and is driven by a 200-hp motor.

DESCRIPTION OF MACHINE

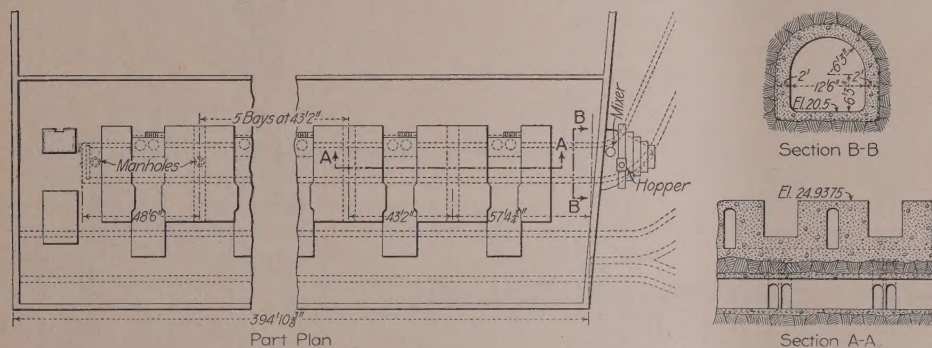
The pneumatic concrete-placing machine, which is patented, consists essentially of a steel cylinder with conical bottom to which is attached the discharge pipe, a funnel at the top for admitting the concrete, and for closing the opening when the batch of concrete is all in, and a compressed-air inlet entering the cylinder just below the top. Each batch of concrete is dumped from the mixer into a steel chute which conveys it to the steel drum. When the batch has been poured into the drum the chute is swung to one side, the top of the drum closed, and the compressed air admitted through the inlet pipes. The compressed air forces the concrete out of the drum and through the discharge pipe to any location desired. At this tunnel concrete has been successfully transported through the pipes a distance of 900 ft.

There is an additional compressed-air inlet located slightly above the junction of bottom cone and the discharge pipe. The compressed air from the upper pipe forces the concrete downward into the discharge outlet. The lower air line agitates the material as it moves from the relatively large area of the drum through a rapidly decreasing cross-section into the discharge pipe. The operation of the pneumatic machine was not successful until this second air line was installed. A 4-in. pipe was first tried on the discharge line, and then a 6-in. pipe, but both proved unsatisfactory. The present 8-in. pipe has proved to be entirely ample in size.

Costs of transporting the concrete by the pneumatic method are made up chiefly as follows:

1. Cost of compressor and plant (installation as well as operation), including power and air lines.

2. Installation of pneumatic machine and discharge pipe, and wear and tear. The rapidly moving gravel and rock scour the pipe rapidly, especially at bends. The minimum bends on this job have 3-ft. radius, and some have been worn out in two days. A more durable metal, as manganese steel,



PLAN AND SECTIONS OF TUNNEL FOR CONDENSER WATER

nels and the position of the turbines above them. The intake for the condenser water to each turbine is accomplished by two vertical wells.

In building the tunnel it was not allowed to break through the floor of the power house, and it was, therefore, necessary to place the lining in the wells from the tunnel underneath. As this would be a difficult piece of work should the concrete be placed by hand, the contractor decided to try the pneumatic method of mixing and placing. A shaft was opened outside of the power house and the tunnel excavation started. First the bottom heading was blasted out and the concrete for the vertical part of the tunnel sides deposited. The mixer was located at the bottom of the shaft, and as only an 8-in. pipe line had to be taken care of in the tunnel the contractor could cheapen the formwork by shoring the forms transversely through the tunnel. After the side lining had set, a wooden floor was placed on it and the arch excavated. Then the arch forms were erected and the lining completed. As shown on the plan, the wells are 43 ft. 2 in. apart. The pipe for conveying the concrete was taken up through one of these wells, braced on top of the arch form and the section filled.

EQUIPMENT

The mixer has a capacity of 7 cu. ft. per batch. It is of the type described in the Current News Section of the Engineering Record of March 8, 1913, page 42. The concrete aggregates are placed by wheelbarrows in a charging hopper at the street level. The quantities are one sack cement, one wheelbarrow of sand and two of washed gravel, making approximately a mixture of

been about 50 ft. per day. The day for placing in the side walls was eight hours, while that for placing the arch was sixteen hours. About 126 cu. yd. were placed per day in the arch by two gangs of sixteen men each.

The cost of placing the concrete, not including any mucking, formwork, etc., was \$55, or 55/126 = 43.5 cents per yard. In addition to this cost the contractor must pay a royalty per yard placed to the lessor of the pneumatic machine, but, it is stated, that even then the cost of placing is less than one-half of the estimated cost had the material been placed by hand.

Compressed air was supplied by a compressor of 557 cu. ft. free air capacity per minute at 100 r.p.m. This machine, however, was speeded up to 125 r.p.m. and gave 650 cu. ft. free air at a pressure of 92 lb. per square inch. The contractor found that when the distance of conveying was long less pressure was needed than for a short distance and explains the phenomenon by the expansion of air in the pipe.

The work is carried out by the Interborough Rapid Transit Company, of which George H. Pegram is chief engineer and William Merriman resident engineer in charge of the work. The contractor for the tunnel is T. J. Brown. The concrete mixer is leased from the Pneumatic Concrete Placing Company, of New York City.

LOST SERVICE through absence of members of its staff on account of sickness, death and other causes in the Chicago Bureau of Water amounted to about 3 per cent in 1913, or 1985 days of the 60,000 days' service required.

is considered best for these sharper bends.

3. Royalty on use of system.

The material travels through the dis-

- 1 Man operating gate on chute from rock bin.
- 1 Man operating gate on chute from sand bin.
- 2 Cement men.
- 1 Mixer operator.
- 1 Man at pneumatic machine.
- 2 Concrete tampers inside tunnel.
- 1 Concrete foreman, who also watches the pipe line to guard against clogging.
- 1 Man operating the air compressor.
- 2 Laborers in the dumping platform above the material bins.

charge pipe at an estimated velocity varying from 3 to 8 ft. per second. The impact of the discharging concrete mass against fresh concrete or against the steel rein-

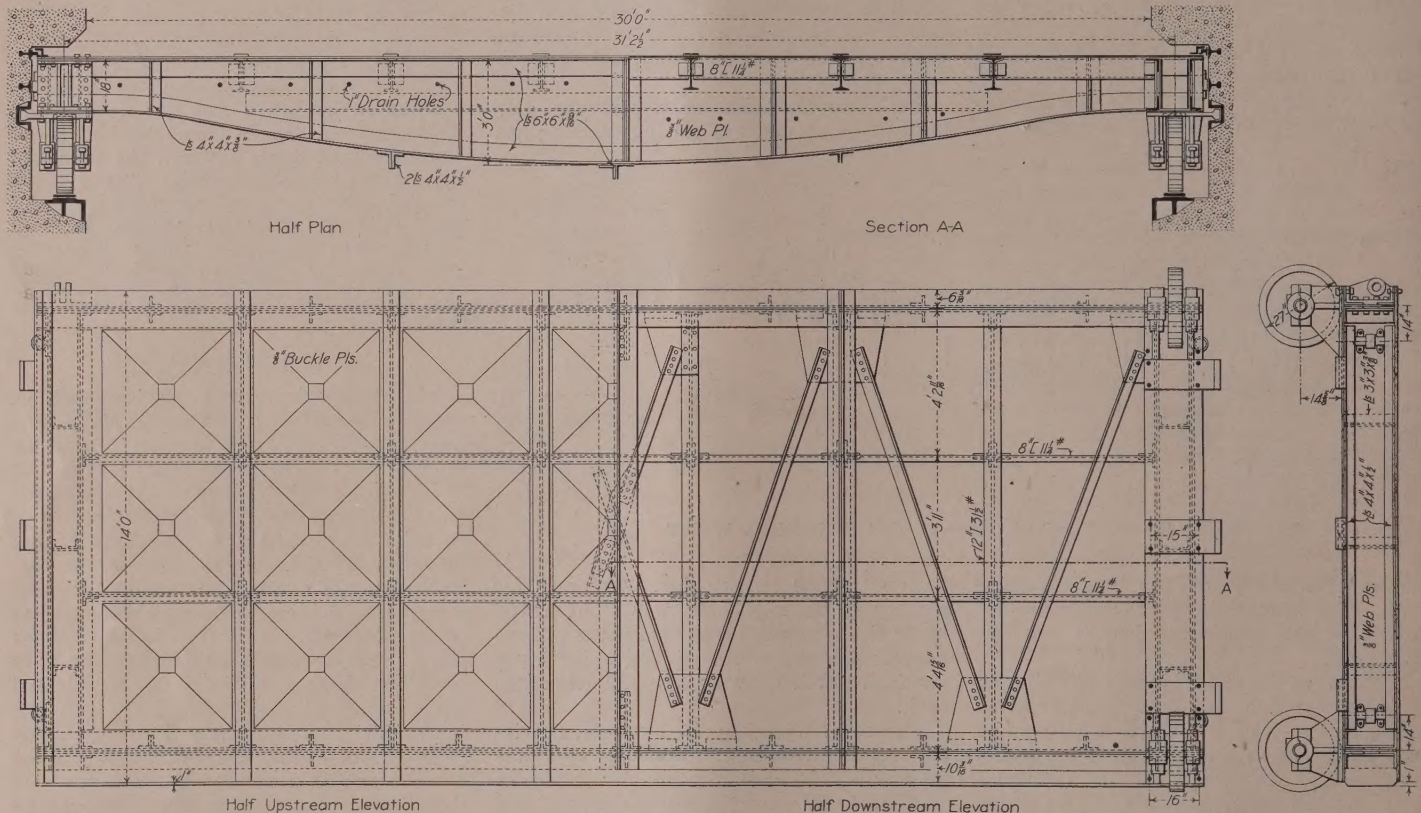
Spillway Gates on Fixed Wheels

Two-Wheeled Trucks Supporting Four Girders
Covered with Buckle Plates Form
a Movable Crest

SPILLWAY gates, twenty-six in number, 14 ft. high, 32 ft. 9 in. wide, 30 ft. free span and mounted on four wheels, are used as a movable crest on top of the spillway section of the dam on the Coosa River at Lock 12 of the Alabama Power Company. The construction of this development was described in the Engineering Record of April 4, page 380. The gates, which are shown in the drawing herewith, have sev-

South African Harbors

THE gradual increase in the size of ships is seriously affecting harbor and dock accommodation in all countries, and the results of the opening of the Panama Canal have given an impetus to trade and shipping. "African Engineering" reports that the Government of South Africa has decided to embark on the schemes for harbor improvement all round the coast of the Union. Work is to be commenced at Durban, where the harbor entrance is to be enlarged, and an auxiliary mole built to protect the south breakwater and pier involving an expenditure of \$9,000,000. The entrance at East London is to be widened and



SPILLWAY GATE WITH BUCKLE PLATES, GIRDERS AND WHEEL TRUCKS AT ENDS

forcement was found to erode the concrete rapidly and to displace the reinforcing steel. To remedy this trouble the pipe was raised so that the discharge end is about 1 ft. above the tunnel arch. The concrete then drops without damage into the forms at the crown and then runs downward on either side to fill up the arch ring.

The total concrete crew required is as shown in the table. Under the most favorable conditions, a batch of 16 cu. ft. can be mixed and placed in a minute. A rate of forty batches per hour or about 190 cu. yd. per 8-hr. day is a fair average when running steadily.

The machine is patented by F. C. Horn, consulting engineer, of Boise, Idaho.

HANGING WALLS OF IMHOFF TANKS in a small installation near Chicago were constructed in sections on the flat, outside of the tank and the wire reinforcement left sticking out of the ends to secure it when placed in proper position, according to L. K. Sherman in discussing a recent paper before the Western Society of Engineers by W. G. Potter on the "Sewage Disposal Plant at Aberdeen, S. D."

eral novel features. Their construction closely resembles that of an overhead traveling crane, at least as far as the girder design and truck arrangement are concerned. Its structural details are shown in the drawing.

Tightening along the crest of the spillway is accomplished by two timbers, one anchored in the masonry with its upper edge flush and the other secured to the bottom of the gate. Along the sides are flexible metal strips to which are fastened longitudinal bars, tightening against the under side of steel rails anchored in the masonry. This device is similar to that used on the Stoney gates of the Panama Canal. As the device is delicate and susceptible to damage, it is protected by a Z-bar.

Guiding the gate is accomplished by metal-lined grooves in the masonry of the gate recesses into which three steel tongues project on each side. This detail prevents upstream and downstream movements of the gate. Transverse movements of the gate are reduced to a minimum by four guide rollers, two on each side of the gate. The gates will be manipulated by an electrically operated traveler from the bridge above the spillway.

improvements costing \$1,800,000 have been planned for Port Elizabeth. The increase of tonnage of vessels calling at South African ports and the congestion due to the lack of wharfage have necessitated the Government adopting this policy.

A DEFECTIVE concrete pavement on Webster Street, San Francisco, caused a dispute between the contractor and the city, the latter refusing to accept the work. The cement, it was claimed, had not been up to standard. Before this fact had been positively decided reports reached the board of supervisors from independent sources and led to an investigation. As a result it was discovered that an unscrupulous junk dealer was offering for sale at a reduced figure "Portland cement" which he sold in sacks bearing the brands of well-known cement companies. On being charged with dealing in inferior cement he denied having any for sale, but hidden beneath piles of junk in his yard were found 1200 bbl. of German cement which had been condemned. Behind the shop was a motor-driven crusher for pulverizing the hardened material.